INTERFACE DESIGN DESCRIPTION
FOR THE
MULTI-MODE MAGNETIC DETECTION SYSTEM

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Prepared for:
Office of Naval Research,
ONR 321
Ballston Tower ONE
800 North Quincy Street,
Arlington, VA 22217-5660

Prepared by:
Polatomic Incorporated
1810 N. Glenville Dr., Ste. 116
Richardson, TX 75081

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3MDS Project
Polatomic Incorporated

Release Approval (Signatures on file):

Name	Title	Date
Rich Tobaben	Software Manager	21 November 2008
Don King	Engineering Director	21 November 2008
Jim Manning	Program Manager	21 November 2008

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7th Revision	G	21 January 2008
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1. SCOPE

1.1 Identification.

This Interface Design Description (IDD) specifies the design for all internal and external software configuration item interfaces on the Multi-Mode Magnetic Detection System (3MDS), and documents the partition of related software development tasks between Polatomic, Inc. (PI) and Applied Signal Technology, Inc. (AST).

1.2 System Overview.

The goal of the 3MDS project is to develop and demonstrate a real-time airborne magnetic detection system that is Unmanned Aerial Vehicle (UAV)-based. The magnetic detection system consists of: a magnetometer, auxiliary sensors for noise reduction, and noise reduction/detection software. The system will be able to perform target search, target detection and, after cueing, perform target re-detection, localization, verification, classification, and tracking in deep water and in the littoral. This system will also support playback of collected data to support training and future algorithm development.

Three proposed variants to the system are planned. A fixed-wing aircraft and manned helicopter variant, a single unmanned aerial vehicle variant, and a dual unmanned aerial vehicle variant. These variants are described in more detail in section 3.

1.3 Document Overview.

This IDD describes the interface characteristics between subsystems of the 3MDS project. The IDD is divided into the following sections:

- Section 1 contains identification and system overview.
- Section 2 lists documents applicable to this program.
- Section 3 contains the interface design descriptions necessary to ensure proper performance of the 3MDS system. This section contains message data layouts of all formats passed through interfaces.
- Section 4 defines requirements traceability.
- Section 5 contains notes and acronyms.
- Section 6 contains appendixes.

1.3.1 Revision Information

This revision is the final revision planned for the 3MDS program and serves to incorporate all Exception Notices published after release of Revision H (21 April 2008). The cumulative changes reflected in this document are indicated by red color text.

2. REFERENCED DOCUMENTS

2.1 Government Documents.

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the contracting agency or as directed by the contracting officer.

2.1.1 Specifications.

Multi-Mode Magnetic Detection System, Contract Number N68335-01-D-0237, MMMDS Preliminary Specification, dated 3/5/2003

2.1.2 Standards.

MIL_STD 498 IDD Data Item Description used as guidance

2.1.2.1 Federal.

None.

2.1.2.2 Military.

None.

2.1.2.3 Other Government Agency.

None.

2.1.3 Drawings.

None.

2.1.4 Other publications.

Multi-Mode Magnetic Detection System, Contract Number: N00014-03-C-0388, Attachment Number 1, Statement of Work, dated 8/1/2003

2.2 Non-Government Documents.

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

2.2.1 Specifications.

None.

2.2.2 Standards.

None.

2.2.3 Other publications.

Davis, J. “A UAV-Based Multi-Mode Magnetic Detection System (3MDS)”, FY05 LASW FNC Execution Plan, June 2004

Novatel Users’ Guide, OEM4 Family of Receivers Command and Log Reference Revision 8 Firmware Version 1.400 dated 5/2/2002

3. INTERFACE DESIGN

This section describes the system, interfaces, and primary data applicable to the 3MDS system.

3.1.1 System Variants

Three known system variants are proposed for the current program. These variants are described in the following subsections.

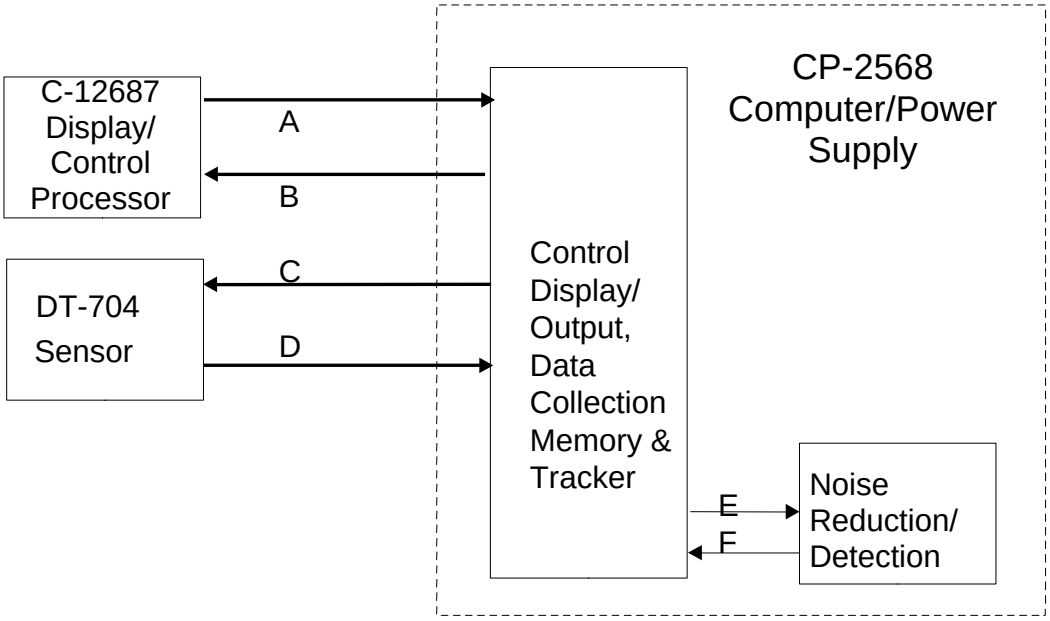


Figure 1 - System Variant I: Fixed Wing Aircraft & Manned Helicopter Platform

Figure 1 depicts the interface connections for an AN/ASQ-233 system operated in a single sensor environment for fixed wing and helicopter installations. The interfaces marked; A, B, C, D, E & F include message Formats listed in Table 2 and fully defined in this document.

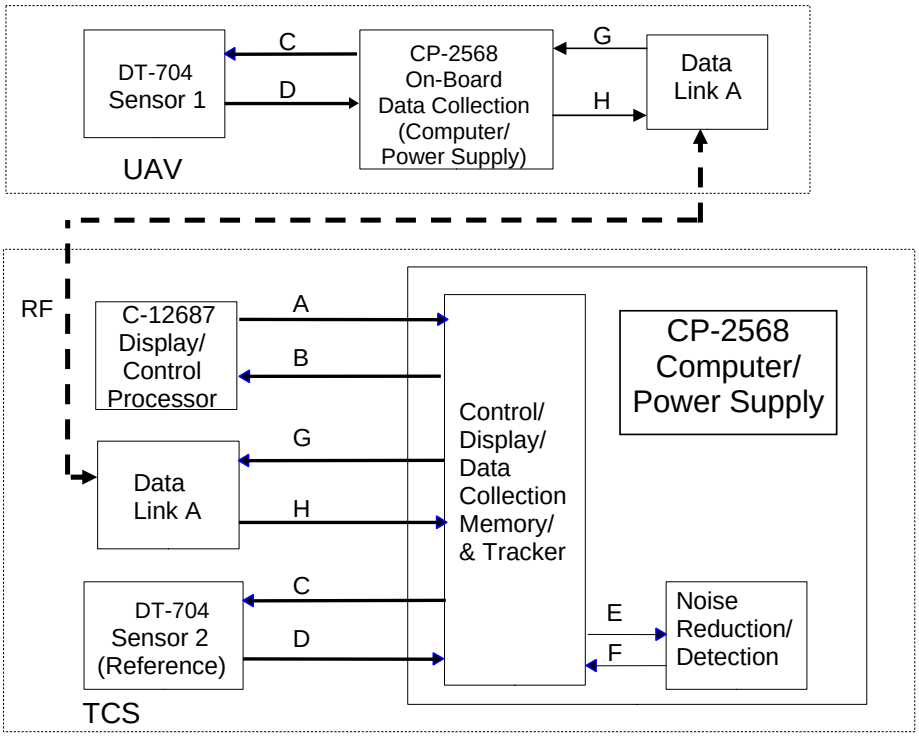


Figure 2 - System Variant II: Single Unmanned Aerial Vehicle Platform

Figure 2 depicts the interface connections for an AN/ASQ-233 system operated in a UAV in conjunction with the Tactical Control Station (TCS) ground unit. The interfaces marked; A, B, C, D, E, F, G, & H F include message Formats listed in Table 2 and fully defined in this document.

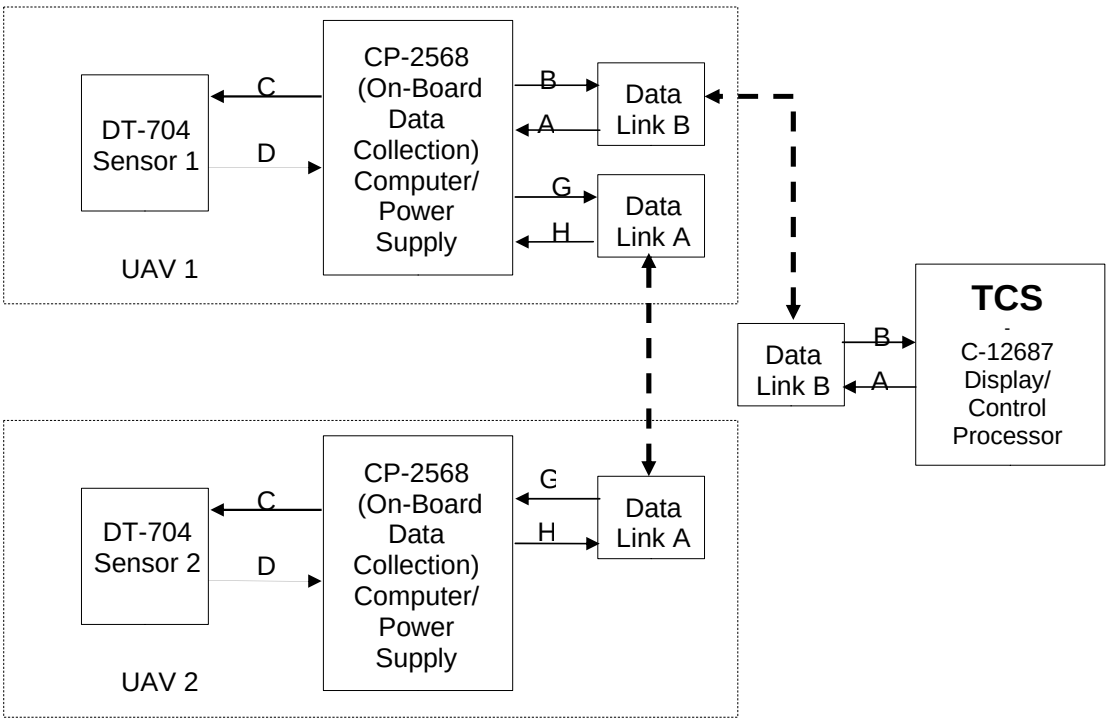


Figure 3 - System Variant III: Dual Unmanned Aerial Vehicle Platform

Figure 3 depicts the interface connections for a dual AN/ASQ-233 system operated in UAV's. The interfaces marked; A, B, C, D, E, F, G, & H F include message Formats listed in Table 2 and fully defined in this document.

3.2 Message Data Interfaces.

The 3MDS system collects data from the AN/ASQ-233 sensor head and places it into message data interfaces for archival and access by the Noise Reduction and Detection module. Input to the Computer/Power Supply is accomplished either directly through Ethernet from the AN/ASQ-233 (System Variant I) or via a radio frequency (RF) data link (Variants II and III).

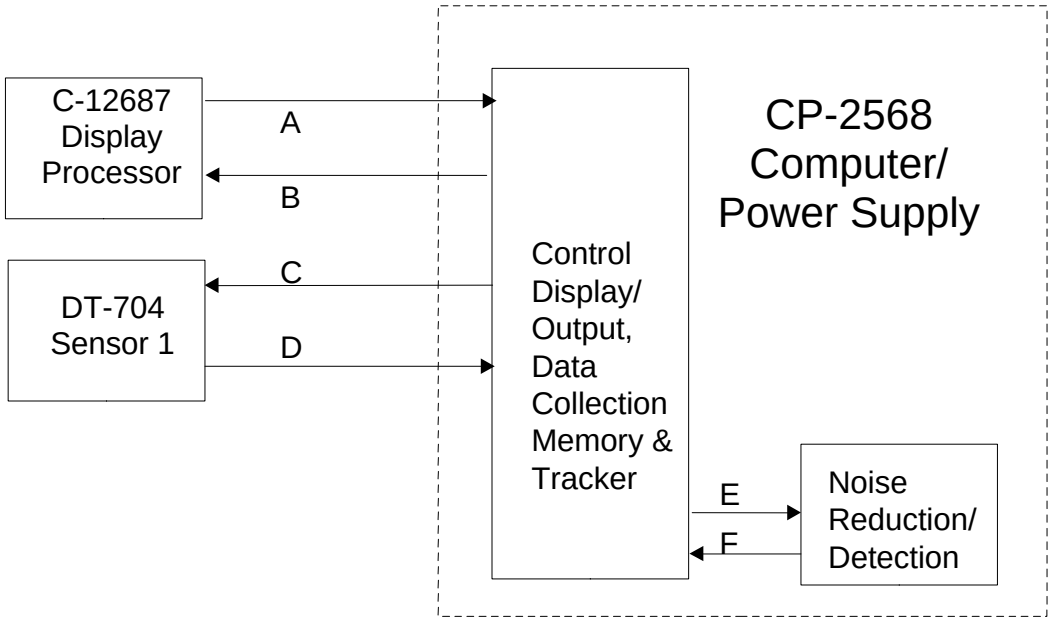
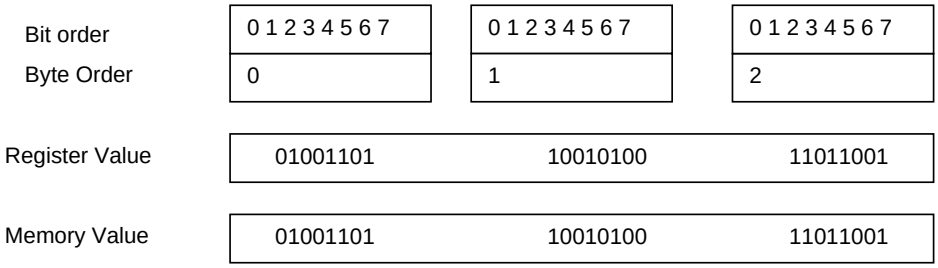


Figure 4 – Message data interfaces for data archival & noise reduction/detection processing

3.3 Formats and Interfaces.

Data is transferred using common message formats through interfaces between subsystems. Formats are logical and functional groupings of data. The message format tables and their sub-field definition tables are listed in Table 1. GPS data, described in paragraph 3.3.2.5, is maintained throughout in Little Endian format. All other data in all Formats is defined in Big Endian format with the most significant byte of a multi-byte item assigned to the byte with the smallest valued address with decreasingly significant bytes assigned subsequently larger valued byte addresses. Likewise, bit assignments are Big Endian with the most significant bit in a bit defined field assigned to the lowest bit position of 0 and adjacent bits assigned to succeeding larger or higher bit positions. An example of the Big Endian address assignment is provided in Figure 5. Interfaces convey a variety of Message Formats. The letters A, B, C, D, E, F, G, and H in Figure 1 through Figure 4 represent data interfaces between subsystems. The relationship between interfaces and formats is specified in Table 2.

Figure 5– Big Endian Byte and Bit Order



3.3.1 GPS Data

All GPS data in Format 1 messages is in Little Endian format as provided by the Novatel GPS board.

Table 1 - List of Message Formats

Message Format Name
Table 25 - Format 4 System Status
Table 26 ENRAD Processing Channel Selection Table
Table 27 Fast Adaptive Pendulum Noise Reduction Reference Channel Selection Options
Table 28 Fast Adaptive Pendulum Noise Reduction Main Channel Selection
Table 29 - **Format 5** Pre-Mapped Target Data
Table 30 - **Format 6** False Target Data Output
Table 31 - **Format 7** Track Data
Table 32 Format 7 Tracker Status Decode
Table **33 -** Format 8 – Detection Data
Table 34 Format 8 Detection Status Decode
Table 35 - **Format 9** Time Domain Noise Reduced Data
Table 36 Format 9 Status Decode
Table 37 - **Format 10** Frequency Domain Real-Time Noise Data
Table 39 - **Format 11** High Speed Debug Data
Table 40 - **Format 12** Start/End Playback/Retrieve
Table 41 - **Format 13** Recorded File Directory Readout
Table 42 - **Format 14** Message Recording Wrapper
Table 43 - **Format-15** Noise Reduction/Detection Processing Control
Table 44 -– Format 15 Mode/Command Decode Option 1 - Test Mode
Table 45 -– Format 15 Mode/Command Decode Option 2 - Normal Mode
Table 46 -– Format 15 Mode/Command Decode Option 3 - Playback Mode
Table 47 - Noise Box Control Decode
Table 48 - ENRAD Processing Channel Selection Table
Table 49 - **Format-16** System Diagnostic Status Information
Table 50 - **Format-17** Noise Reduction/Detection Initialization Status
Table 51 – **Format 18** Command Track Generation
Table 52 - **Format 19** Tracker Input Data

Table 2 - Interface/Format Relationship

Interface	Originator	Transfers Message Formats	Netcentric Data
A	Display Processor	3, 4, 18	5
B	Computer/Power Supply	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13,14, 16	6
C	Computer/Power Supply	1, 3, 12	
D	Sensor	1, 2, 3, 11,12	
E	Control/Display/Output/Tracker	1,12, 15	5
F	Noise Reduction/Detection	8, 9, 10	6
G	Computer/ Power Supply	1, 3, 4	
H	Airborne Computer/ Power Supply	1, 2, 3, 4,11, 12, 13,14	

The formats are described in detail in the following paragraphs.

3.3.2 Format 1 – Sensor Data and Control Response

Table 3 - Format 1 Sensor Data and Control Response summarizes the message data layout for Format 1 which contains Sensor Data and Control Response to and from the Computer/Power Supply, Display processor, and the DT-704 sensor. Other than the total field magnetometer signal, each data block contains output from a vector magnetometer, a three-axis accelerometer, and a Novatel Global Positioning System (GPS) unit contained within the AN/ASQ-233 sensor head. Built-In Test (BIT) and control status words are recorded as well. Detailed formats for the Control Status-Search/Reference Designation, Manufacturer Serial Number, BIT Status Decode, and the GPS data are described in following paragraphs.

Table 3 - Format 1 Sensor Data and Control Response

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000001B
1	Reserved	24	TBD
4	Message Length	32	93
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Sample Count	32	1
16	Control Status-Search/Reference Designation	16	1
18	Compensated Total Field	64	nT (DPFP)
26	DT-704 Uncompensated Total Field Cluster A, or Magnetometer A	40	6.4906×10^{-7} nT (See Note 1)
31	DT-704 Uncompensated Total Field Cluster B, or Magnetometer B	40	6.4906×10^{-7} nT (See Note 1)
36	Vector Magnetometer—T Component (See Note 2)	24	0.0077486 nT
39	Vector Magnetometer—L Component (See Note 2)	24	0.0077486 nT
42	Vector Magnetometer—D Component (See Note 2)	24	0.0077486 nT
45	Vector Magnetometer Corrected—T Component (See Note 2)	64	nT (DPFP)
53	Vector Magnetometer Corrected—L Component (See Note 2)	64	nT (DPFP)
61	Vector Magnetometer Corrected—D Component (See Note 2)	64	nT (DPFP)
69	3-Axis Accelerometer—T Component (See Note 2)	16	0.120 mG
71	3-Axis Accelerometer—L Component (See Note 2)	16	0.120 mG
73	3-Axis Accelerometer—D Component (See Note 2)	16	0.120 mG
75	Sensor Status	32	See Sensor Status Decode
79	Closest Match Sample Count	32	1 (See Note 3)

[1] $20 \times 10^6/(28.025 \times 2^{40})$ represents the expression from which the 6.4906×10^{-7} LSB value is derived, where 28.025 is the conversion scale factor from Frequency (Hz) to magnetic field (nT). 2^{40} accounts for the field size in bits. 20×10^6 represents the idealized clock speed in MHz. This LSB value will remain constant regardless of the actual clock speed.

[2] T is Transverse with Positive North on West heading, L is Longitudinal with Positive South on North heading, D is Positive Down.

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
83	Sensor BIT Status	16	See Sensor BIT Status Decode
85	GPS Buffer Offset	8	
86	GPS Data Buffer	56	

3.3.2.1 Control Status-Search/Reference Designation

The following table defines the elements of Control Status – Search/Reference Designation provided in Format 1 by the DT-704 sensor. These codes are written once every system cycle (430.44 Hz) as a 16-bit field to the message data block starting at byte address 16, and can be used to identify both control status (commanded and acknowledged) as well as reference and search sensor designation.

Table 4 - Format 1 Control Status – Search/Reference Designation

Control Status – Search/Reference Designation			
Subfield Alignment (Left to Right) 0----------15	**Item**	**Field Length (Bits)**	**Definition**
0-----11	Control Status	12	See Control Status Decode
12------15	Search/Reference Designation	4	See Table 6 - Sensor Search/Reference Designation Decode

3.3.2.1.1 Control Status Decode for Format 1

Table 5 provides the control status decode for control of the DT-704 total field magnetometer. One of these codes is output every system cycle (430.44 Hz) as a 12-bit field to the message data block at the starting byte address 16 in response to commanded operation, and can be used by other system functions to monitor the status of the total field magnetometer operation.

Table 5 - Format 1 Control Status Decode

Control Status Value		Definition
Command/ Response	**(Binary)**	
(1/0)	000 00000000	No Change
(1/0)	000 00000001	Send format 00000001B (toggles format 00001011B OFF)
(1/0)	000 00000010	Send format 00000010B once
(1/0)	000 00000011	Send format 00000011B once
(1/0)	000 00000100	Send format 00001011B (toggles format 00000001B OFF)
(1/0)	000 00000101	Do not transmit any formats

[3] Closest Match Sample Count is added to Format 1 by Sensor-to-Sensor Data Alignment to indicate best time matched samples in two sensor data streams. If no second sensor data stream exists or if no sample count matches this sample within limits, the value is zero, and "Closest Match Sample Count Valid" in Sensor Status Field is set to "False".

Control Status Value		Definition
Command/ Response	(Binary)	
(1/0)	000 00000110	Synchronize/Reset Sampling at Next GPS PPS Pulse
(1/0)	000 00000111	Reset (Reboot)
(1/0)	000 00001000	Auto BIT
(1/0)	000 00001001	BIT Stop
(1/0)	000 00001010	Test Processor
(1/0)	000 00001011	Test Sensor
(1/0)	000 00001100	Test GPS
(1/0)	000 00001101	Test Vector
(1/0)	000 00001110	Test Laser/Driver
(1/0)	000 00001111	Test Resonance PWB
(1/0)	000 00010000	Send Sensor Optimization Coefficients
(1/0)	000 00010001	Apply Received Sensor Optimization Coefficients
(1/0)	000 00010010	Compensation Coefficient Application Begun
(1/0)	000 00010011	Optimize
(1/0)	000 00010100	Compensator coefficients applied
(1/0)	000 00010101	Not assigned
(1/0)	000 00010110	Open laser loop
(1/0)	000 00010111	Close laser loop
(1/0)	000 00011000	Open resonance A loop
(1/0)	000 00011001	Close resonance A loop
(1/0)	000 00011010	Connect RO sweep D/A 1
(1/0)	000 00011011	Connect RO sweep D/A 2
(1/0)	000 00011100	Connect laser sweep D/A 1
(1/0)	000 00011101	Connect laser sweep D/A 2
(1/0)	000 00011110	Connect AX error signal D/A 1
(1/0)	000 00011111	Connect AX error signal D/A 2
(1/0)	000 00100000	Connect AY error signal D/A 1
(1/0)	000 00100001	Connect AY error signal D/A 2
(1/0)	000 00100010	Connect AZ error signal D/A 1
(1/0)	000 00100011	Connect AZ error signal D/A 2
(1/0)	000 00100100	Connect BX error signal D/A 1
(1/0)	000 00100101	Connect BX error signal D/A 2
(1/0)	000 00100110	Connect BY error signal D/A 1
(1/0)	000 00100111	Connect BY error signal D/A 2
(1/0)	000 00101000	Connect BZ error signal D/A 1
(1/0)	000 00101001	Connect BZ error signal D/A 2
(1/0)	000 00101010	Connect summed error signal D/A 1
(1/0)	000 00101011	Connect summed error signal D/A 2
(1/0)	000 00101100	Connect summed chopper D/A 1
(1/0)	000 00101101	Connect summed chopper D/A 2
(1/0)	000 00101110	AX sum ON
(1/0)	000 00101111	AX sum OFF
(1/0)	000 00110000	AY sum ON
(1/0)	000 0110001	AY sum OFF
(1/0)	000 00110010	AZ sum ON
(1/0)	000 00110011	AZ sum OFF
(1/0)	000 00110100	BX sum ON
(1/0)	000 00110101	BX sum OFF
(1/0)	000 00110110	BY sum ON

Control Status Value		Definition
Command/ Response	(Binary)	
(1/0)	000 00110111	BY sum OFF
(1/0)	000 00111000	BZ sum ON
(1/0)	000 00111001	BZ sum OFF
(1/0)	000 00111010	Connect RO AGC D/A 1
(1/0)	000 00111011	Connect RO AGC D/A 2
(1/0)	000 00111100	Connect laser AGC D/A 1
(1/0)	000 00111101	Connect laser AGC D/A 2
(1/0)	000 00111110	Open resonance B loop
(1/0)	000 00111111	Close resonance B loop
(1/0)	000 01000000	Open resonance C loop
(1/0)	000 01000001	Close resonance C loop
(1/0)	000 01000010	Open resonance D loop
(1/0)	000 01000011	Close resonance D loop
(1/0)	000 01000100	Playback ON
(1/0)	000 01000101	Playback OFF
(1/0)	000 01000110	Lock laser to AX
(1/0)	000 01000111	Lock laser to AY
(1/0)	000 01001000	Lock laser to AZ
(1/0)	000 01001001	Lock laser to BX
(1/0)	000 01001010	Lock laser to BY
(1/0)	000 01001011	Lock laser to BZ
(1/0)	.000 01001100	[not assigned] (see Note 4)
(1/0)	.	.
(1/0)	.	.
(1/0)	000 10000000	[not assigned] (see Note 4)

Commands are sent from the CP-2568, Computer/Power Supply, to the DT-704, sensor, with Command/Response set to 1. The DT-704 acknowledges and responds with the indicated Command Value and the Command/Response set to 0 in a subsequent Format 1 output when, either the command has been acted upon, or the commanded activity has been initiated, depending upon the nature of the commanded action. For commands that cause interruption in Format 1 Message transmission, such as "*Send format 00001011B*" and "*Do not transmit any formats*", one Format 1 will be sent to acknowledge the command. Normal Format 1 output by the DT-704 will include a Control Status of 0000 00000000 reporting no change from last command.

[4] No Control Status definition assigned

3.3.2.1.2 Sensor Search/Reference Designation Decode for Format 1

Table 6 defines the valid settings for the Sensor Search/Reference Designation Field of the Control Status – Search/Reference Designation item found at byte offset 16 of the Format 1 message. This field is used to indicate which of two streams of DT-704 sensor data is to be used as reference data and which is to be treated as search data for noise reduction purposes. Prior to designation in any system operation, all sensors will report “No Designation”, 0000B.

Table 6 - Sensor Search/Reference Designation Decode

Sensor Search/Reference Designation (Binary)	Definition
0000	No Designation (Test)
0001	Search
0010	Reference
0011	Not Defined
:	Not Defined
:	Not Defined
1111	Not Defined

3.3.2.2 Manufacturer Serial Number

The Manufacturer Serial Number (MSN) field, described in Table 7 consists of a Component Type sub-field and a Component Serial Number sub-field which, together, define a unique identifying number. Table 8 defines the valid settings of the Component Type sub-field.

Table 7 - Manufacturer Serial Number

Manufacturer Serial Number			
Subfield Alignment (Left to Right) 0----------15	**Item**	**Field Length (Bits)**	**Definition**
0---3	Component Type	4	See Component Type Decode
4----------15	Component Serial Number	12	Assigned Serial Number

Table 8 - Component Type Decode

Type Code (Binary)	Definition
0000	P2000 (test)
0001	DT-704 Sensor
0010	Computer Power Supply (Detection Capable) CPS Control
0011	Computer Power Supply (Record & Relay) CPS Control
0100	Display/Control Processor
0101	Display Processor
0110	Test Controller
0111	CPS Noise Reduction Detection
1000	Maintenance Console
:	Not Defined
:	Not Defined
1111	Not Defined

3.3.2.3 Sensor Status Decode for Format 1

Table 9 provides the definition of the Sensor Status field from the DT-704 sensor. These codes are written once every system cycle (430.44 Hz) as a 4-byte field to the message data block starting at byte address 75, for use by control and processing components of the system to monitor sensor status.

Table 9 Sensor Status Field Decode

Sensor Status Field		
Sub-Field Bit Position 0----------7	**Field Name**	**Definition**
0	Sample Count Reset on this Sample	0 = False, 1 = True
1	Sample Count Rejected by Alignment Function[5]	0 = False, 1 = True
2	Laser Locked	0 = False, 1 = True
3	Sensor Locked	0 = False, 1 = True[6]
4	Closest Match Sample Count Valid	0 = False, 1 = True[7]
5	Noise Box Sample	0 = False, 1 = True[8]
6	Not Assigned	0
*	*	0
*	*	0
*	*	0
*	*	0
*	*	0
*	*	0
*	*	0
*	*	0
15	Not Assigned	0
16	Laser Locked	0 = False, 1 = True
17	Mag Locked	0 = False, 1 = True
18	Cell A sustain	0 = False, 1 = True
19	Cell B sustain	0 = False, 1 = True
20	Cell C sustain	0 = False, 1 = True
21	Cell D sustain	0 = False, 1 = True
22	Cell E sustain	0 = False, 1 = True
23	Cell F sustain	0 = False, 1 = True
24	Laser Sweeping	0 = False, 1 = True
25	Mag Sweeping	0 = False, 1 = True
26	Sensor Balanced	0 = False, 1 = True
27	Temp Above 55°C	0 = False, 1 = True
28	Temp Above 65°C	0 = False, 1 = True
29	Spare	
30	Spare	
31	Spare	

[5] Assigned at Detection CPS indicating a sample not supplied to Noise Reduction/Detection.
[6] Sensor Locked = False indicates the sample is not to be supplied to Noise Reduction/Detection because sensor data fields have not stabilized.
[7] Assigned at Detection CPS indicating the sample contains a valid Closest Match Sample Count value
[8] Assigned at Detection CPS Control indicating the sample has been saved for Noise Box reprocessing by Noise Reduction/Detection Processor.

3.3.2.4 Sensor BIT Status Decode for Format 1

The following table provides the sensor BIT status decode provided by the DT-704 sensor. These codes are written once every system cycle (430.44 Hz) as a 2-byte field to the message data block starting at byte address 83, and can be used by the noise reduction and detection processor to monitor system status.

Table 10 - Format 1 Sensor BIT Status Decode

BIT Test Value (Binary)	Definition
00000000 00000000	No detected failures; operation normal
00000000 00000001	Processor Board Time-Out Failure
00000000 00000010	Processor Board Real-Time BIT Failure
00000000 00000011	Processor Board Dedicated BIT Failure
00000000 00000100	Loop Board Time-Out Failure
00000000 00000101	Loop Board Real-Time BIT Failure
00000000 00000110	Loop Board Dedicated BIT Failure
00000000 00000111	Sensor Time-Out Failure
00000000 00001000	Sensor Real-Time BIT Failure
00000000 00001001	Sensor Dedicated BIT Failure
00000000 00001010	GPS Time-Out Failure
00000000 00001011	GPS Real-Time Failure
00000000 00001100	GPS Dedicated BIT Failure
00000000 00001101	Vector Magnetometer Time-Out Failure
00000000 00001110	Vector Magnetometer Real-Time BIT Failure
00000000 00001111	Vector Magnetometer Dedicated BIT Failure
00000000 00010000	[not assigned] (see Note 9)
.	.
.	.
11111111 11111111	[not assigned] (see Note **9**)

3.3.2.5 GPS Data for Format 1

The following table provides the format of the GPS position and time data recorded to the message data block[10]. For complete GPS details refer to the Novatel Users' Guide OEM4 Family of Receivers Command and Log Reference Revision 8 Firmware Version 1.400.

Table 11 - GPS Data Buffer Format Definition for 10 Hz Logs

Relative Base Address (bytes)	Item	Size (bits)	Definition
0	Markposb (binary) log	832	ONNEW (Event Mark) Asynch trigger for every 44th 430 Hz sample = 9.77 Hz
104	Bestposb (binary) log	832	ONTIME 0.10 synch trigger (100 msec = 10 Hz, synchronous with GPS sec)
208	bestvelb (binary) log	608	ONTIME 0.10 synch trigger (100 msec = 10 Hz, synchronous with GPS sec)

[9] No sensor BIT status definition assigned.

[10] GPS data will not actually be available if the GPS antenna is not installed or is unable to locate a satellite constellation.

284	filler(spare)	192	

GPS Log Notes:

1. The Novatel OEM4 GPS Receiver User's Guide (Vol. 1 & 2) in PDF form is available at www.novatel.ca. The Tables below, Table 12 through Table 17, describing GPS log formats are excerpted from the Novatel OEM4 GPS Receiver User's Guide (Vol. 1 & 2) and are copyrighted by Novatel, Inc.
2. Each log has a header that contains header length, message ID, message length, Idle Time, Time Status, Time (type of time depends on log), Receiver Status.

Table 12 - Binary Message Header Structure

Field #	Field Name	Field Type	Description	Binary Bytes	Binary Offset	Ignoredon Input
1	Sync	Char	Hexadecimal 0xAA.	1	0	N
2	Sync	Char	Hexadecimal 0x44.	1	1	N
3	Sync	Char	Hexadecimal 0x12.	1	2	N
4	Header Length	Uchar	Length of the header.	1	3	N
5	Message ID	Ushort	This is the Message ID number of the.	2	4	N
6	Message Type	Char	Bits 0-4 = Reserved Bits 5-6 = Format 00 = Binary 01 = ASCII 10 = Abbreviated ASCII, NMEA 11 = Reserved Bit 7 = Response Bit 0 = Original Message 1 = Response Message	1	6	N
7	Port Address	Char	(decimal values greater than 16 may be used) (lower 8 bits only) a	1	7	N b
8	Message Length	Ushort	The length in bytes of the body of the message. This does not include the header nor the CRC.	2	8	N
9	Sequence	Ushort	This is used for multiple related logs. It is a number that counts down from N-1 to 0 where N is the number of related logs and 0 means it is the last one of the set. Most logs only come out one at a time in which case this number is 0.	2	10	N
10	Idle Time	Char	The percentage of time that the processor is idle in the last second. Take the time (0 - 200) and divide by two to give the percentage of time (0 - 100%).	1	12	Y
11	Time Status	Enum	Indicates the quality of the GPS	1 c	13	N d
12	Week	Ushort	GPS week number.	2	14	N d
13	Milliseconds	GPSec	Milliseconds from the beginning of the GPS week.	4	16	N d
14	Receiver Status	Ulong	32 bits representing the status of various hardware and software components of the receiver	4	20	Y
15	Reserved	Ushort	Reserved for internal use.	2	24	Y
16	Receiver S/W Version	Ushort	This is a value (0 - 65535) that represents the receiver software build number.	2	26	Y

3. The 430 Hz sample Mark Event time of the markposb log is associated with the 1st of 44 (430 Hz) samples (identified by the GPS Buffer Offset Count = 0).

Table 13 - *MARKPOS, MARK2POS Position at Time of Mark Input Event*

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header		H	0
2	sol status	Solution status (see *Table 12, Solution Status,*)	Enum	4	H
3	pos type	Position type (see *Table 11,*)	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid (m)	Float	4	H+32
8	datum id#	Datum ID number	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#obs	Number of observations tracked	Uchar	1	H+64
16	#GPSL1	Number of GPS L1 ranges used in computation	Uchar	1	H+65
17	#L1	Number of GPS L1 ranges above the RTK mask angle	Uchar	1	H+66
18	#L2	Number of GPS L2 ranges above the RTK mask angle	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20			Uchar	1	H+69
21			Uchar	1	H+70
22			Uchar	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

This log contains the estimated position of the antenna when a pulse is detected at a mark input. MARKPOS is a result of a pulse on the MK1I input and MARK2POS is generated when a pulse occurs on a MK2I input.

The position at the mark input pulse is extrapolated using the last valid position and velocities. The latched time of mark impulse is in GPS weeks and seconds into the week. The resolution of the latched time is 49 ns.

4. The GPS Week (2 bytes) and GPS milli-Seconds (4 Bytes) in the Header of the markposb log are located with byte offsets of 14 and 16 into the GPS Data Buffer. These also equate to byte offsets of 0 and 2 of the 3MDS Format 1 data sample whose GPS Buffer Offset Count = 2. (GPS Buffer Offset Count has a byte offset of 85 in every 3MDS Format 1 data (430 Hz) sample).
5. The Lat (8 bytes) and Lon (8 bytes) of the markposb log are located with byte offsets of H(Hdr len)+8 = 28+8=36 and H+16=28+16=44 into the GPS Data Buffer. For the Lat, this equates to a byte offset of 1 of the 3MDS Format 1 data sample whose GPS Buffer Offset Count = 5. For the

Lon, this equates to a byte offset of 2 of the 3MDS Format 1 data sample whose GPS Buffer Offset Count = 6. (GPS Buffer Offset Count has a byte offset of 85 in every 3MDS Format 1 data (430 Hz) sample).

6. The Altitude (8 bytes) in meters of the markposb log is located with a byte offset of H(Hdr len)+24 = 28+24=52 into the GPS Data Buffer. This equates to a byte offset of 3 of the 3MDS Format 1 data sample whose GPS Buffer Offset is 7.
7. The GPS milli-Seconds (4 bytes) in the Header of the bestposb log is located with a byte offset of 120 into the GPS Data Buffer. This also equates to a byte offset of 1 of the 3MDS Format 1 data sample whose GPS Buffer Offset Count = 17. (GPS Buffer Offset Count has a byte offset of 85 in every 3MDS Format 1 data (430 Hz) sample.
8. The GPS milli-Seconds (4 bytes) in the Header of the bestvelb log is located with a byte offset of 224 into the GPS Data Buffer. This also equates to a byte offset of 0 of the 3MDS Format 1 data sample whose GPS Buffer Offset Count = 32.

Table 14 - *BESTPOS Best Position*

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header		H	0
2	sol status	Solution status, see *Table 12)*	Enum	4	H
3	pos type	Position type, see *Table 11*	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid (m)	Float	4	H+32
8	datum id#	Datum ID	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#obs	Number of observations tracked	Uchar	1	H+64
16	#GPSL1	Number of GPS L1 ranges used in computation	Uchar	1	H+65
17	#L1	Number of GPS L1 ranges above the RTK mask angle	Uchar	1	H+66
18	#L2	Number of GPS L2 ranges above the RTK mask angle	Uchar	1	H+67
19	Reserved		Uchar	1	H+68
20			Uchar	1	H+69
21			Uchar	1	H+70
22			Uchar	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

This log contains the best available combined GPS and inertial navigation system (INS - if available) position computed by the receiver. In addition, it reports several status indicators, including differential

age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

With the system operating in an RTK mode, this log will reflect the latest low-latency solution for up to 60 seconds after reception of the last base station observations. After this 60 second period, the position reverts to the best solution available; the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudorange differential solutions continue for the time specified in the DGPSTIMEOUT command.

Table 15 - Position or Velocity Type

Position Type(binary)	Position Type (ASCII)	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command
2	FIXEDHEIGHT	Position has been fixed by the FIX HEIGHT/AUTO command
3	Reserved	
4	FLOATCONV	Solution from floating point carrier phase ambiguities
5	WIDELANE	Solution from widelane ambiguities
6	NARROWLANE	Solution from narrowlane ambiguities
7	Reserved	
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
9-15	Reserved	
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	WAAS	Solution calculated using corrections from an SBAS
19	PROPAGATED	Propagated by a Kalman filter without new observations
20	OMNISTAR	OmniSTAR VBS position (L1 sub-meter) a
21-31	Reserved	
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionospheric-free ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
51	RTK_DIRECT_INS	RTK status where the RTK filter is directly initialized from the INS filter b
52-56	INS calculated position types b	
64	OMNISTAR_HP	OmniSTAR HP position (L1/L2 decimeter) a
65	Reserved	

a. *In addition to a NovAtel OEM4 family receiver, a NovAtel OmniSTAR L-Band receiver and a subscription to the OmniSTAR service are required. Contact NovAtel for details.*

b. *Output only by the BESTPOS and BESTVEL logs when using an inertial navigation system such as NovAtel's SPAN products.*

c. *Output only when using an inertial navigation system..*

d. *PENDING implies there are not enough satellites being tracked to verify if the FIX POSITION entered into the receiver is valid. The receiver needs to be tracking two or more GPS satellites to perform this check. Under normal conditions you should only see PENDING for a few seconds on power up before the GPS receiver has locked onto its first few satellites. If*

your antenna is obstructed (or not plugged in) and you have entered a FIX POSITION command, then you may see PENDING indefinitely.

Table 16 - Solution Status

Solution Status (Binary)		Description
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
2	NO_CONVERGENCE	No convergence
3	SINGULARITY	Singularity at parameters matrix
4	COV_TRACE	Covariance trace exceeds maximum (trace > 1000 m)
5	TEST_DIST	Test distance exceeded (maximum of 3 rejections if distance > 10 km)
6	COLD_START	Not yet converged from cold start
7	V_H_LIMIT	Height or velocity limits exceeded (in accordance with COCOM export licensing restrictions)
8	VARIANCE	Variance exceeds limits
9	RESIDUALS	Residuals are too large
10	DELTA_POS	Delta position is too large
11	NEGATIVE_VAR	Negative variance
12	Reserved	
13	INTEGRITY_WARNING	Large residuals make position unreliable
14-17	INS solution status values [a]	
18	PENDING	When a FIX POSITION command is entered, the receiver computes its own position and determines if the fixed position is valid [b]
19	INVALID_FIX	The fixed position, entered using the FIX POSITION command, is not valid

Table 17 - *BESTVEL Best Available Velocity Data*

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	header	Log header		H	0
2	sol status	Solution status	Enum	4	H
3	vel type	Velocity type	Enum	4	H+4
4	latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
5	age	Differential age in seconds	Float	4	H+12
6	hor spd	Horizontal speed over ground, in meters per second	Double	8	H+16
7	trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	vert spd	Vertical speed, in meters per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

This log contains the best available velocity information computed by the receiver. In addition, it reports a velocity status indicator, which is useful in indicating whether or not the corresponding data is valid. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value.

The velocity is typically computed from the average change in pseudorange over the time interval or the RTK Low Latency filter. As such, it is an average velocity based on the time difference between successive position computations and not an instantaneous velocity at the BESTVEL time tag. The velocity latency to be subtracted from the time tag will normally be 1/2 the time between filter updates. Under default operation, the positioning filters are updated at a rate of 2 Hz. This translates into a velocity latency of 0.25 second. The latency can be reduced by increasing the update rate of the positioning filter being used by requesting the BESTVEL or BESTPOS messages at a rate higher than 2 Hz. For example, a logging rate of 10 Hz would reduce the velocity latency to 0.005 seconds. For integration purposes, the velocity latency should be applied to the record time tag.

While you are standing still, your velocity may jump several centimetres per second. Once you start moving, your velocity will become less noisy. The latency of the instantaneous doppler velocity is always 0.15 seconds. You will know that you have an instantaneous doppler velocity solution when you see DOPPLER_VELOCITY in field #3 (vel type) below. BESTVEL uses an instantaneous doppler velocity that has low latency and is not delta position dependent. If you change your velocity quickly, you can see this in the DOPPLER_VELOCITY solution.

A valid solution with a latency of 0.0 indicates that the instantaneous Doppler measurement was used to calculate velocity.

3.3.3 Format 2 – Sensor Control Data

Table 18 summarizes the message data layout for Format 2 which contains Sensor Control Data sent between the Maintenance Console laptop, the Display/Computer/Power Supply, and the DT-704 sensor.

Table 18 - Format 2 Sensor Internal Control Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000010B
1	Reserved	24	TBD
4	Message Length	32	272
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Sample Count	32	1
16	FPGA Write Block Definition		See Table 19
144	FPGA Read Block Definition		See Table 20

Table 19 FPGA Write/Read Block Definition

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Relative Base Address (bytes)	FPGA Address	Item	Size (bits)	Definition Units/LSB Value/Other
16	4000000	Serial DAC Spare	16	0000
18	4000002	Serial DAC Spare	16	0000
20	4000004	Serial DAC Spare	16	0000
22	4000006	Serial DAC Spare	16	0000
24	4000008	clk adjust	16	0000
26	400000A	Serial DAC Spare	16	0000
28	400000C	Serial DAC for Laser Temp	16	4000
30	400000E	Serial DAC for Laser Current	16	8E80
32	4000010	RF_Gain A	16	8000
34	4000012	RF_Gain B	16	8000
36	4000014	RF_Gain C	16	8000
38	4000016	RF_Gain D	16	8000
40	4000018	RF_Gain E	16	8000
42	400001A	RF_Gain F	16	8000
44	400001C	D/A Spare G	16	0000
46	400001E	D/A Spare H	16	0000
48	4000020	PWM Piezo A	16	6230

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Relative Base Address (bytes)	FPGA Address	Item	Size (bits)	Definition Units/LSB Value/Other
50	4000022	PWM Piezo B	16	6230
52	4000024	PWM Piezo C	16	6230
54	4000026	PWM Piezo D	16	6230
56	4000028	PWM Piezo E	16	6230
58	400002A	PWM Piezo F	16	6230
60	400002C	Set the starting place for temp sweep	16	4000
62	400002E	Threshold for Laser Auto Lock	16	FFE0, LSB
64	4000030	Threshold for Laser Auto Lock	16	FFFF, MSB
66	4000032	Set the starting place for mag sweep	16	3000
68	4000034	19kdelayload	16	005C
70	4000036	lasercurrentdcld	16	4800, not in use
72	4000038	sweepdevload	16	0005
74	400003A	9p5kdelayload	16	0108
76	400003C	9p5kdetlevelset[15..0]	16	0000, used to make modulation off of D0
78	400003E	testpointcontrol	16	A213
80	4000040	controlword	16	0B98
82	4000042	magfiltersgain[15..0]	16	502F
84	4000044	magerrorgain[15..0]	16	4F44
86	4000046	magcenterfreq[15..0]	16	0000
88	4000048	magcenterfreq[31..16]	16	2407
90	400004A	432sweepdelay	16	3800
92	400004C	magsweepdevwrite	16	005D, Mag Sweep Amplitude
94	400004E	864sweepdelay	16	1800
96	4000050	19kdetlevelset[15..0]	16	
98	4000052	19kdetlevelset[31..16]	16	
100	4000054	agcsetpointA[15..0]	16	
102	4000056	agcsetpointA[31..16]	16	
104	4000058	Dig Resistor Value A,B	16	3A/135
106	400005A	Dig Resistor Value C	16	14E
108	400005C	Dig Resistor Value D,E	16	3A/135
110	400005E	Dig Resistor Value F	16	153
112	4000060	Sends Dig Resistor Value	16	
114	4000062	Startup	16	
116	4000064	Resets DPC and Re-sync 430 to PPS	16	0000, Aligns data to GPS
118	4000066	lasersyncdetgain[15..0]	16	000C
120	4000068	lasererrorgain[15..0]	16	2FC1
122	400006A	NEWERcontrol	16	0000
124	400006C	NEWcontrol	16	3008
126	400006E	debugcontrol	16	0000
128	4000070	morecontrol	16	0042
130	4000072	Threshold for Mag Auto Lock	16	0000, LSB
132	4000074	Threshold for Mag Auto Lock	16	0500, MSB
134	4000076	agcsetpointC[15..0]	16	
136	4000078	agcsetpointC[31..16]	16	
138	400007A	Accel Adjust X	16	
140	400007C	Accel Adjust Y	16	

Relative Base Address (bytes)	FPGA Address	Item	Size (bits)	Definition Units/LSB Value/Other
142	400007E	Accel Adjust Z	16	

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Table 20 FPGA Read Block Definition

Relative Base Address (bytes)	FPGA Address	Item	Size (bits)	Definition Units/LSB Value/Other
144	4000080	Vector Z LSB	16	T
146	4000082	Vector Z MSB	16	T
148	4000084	Vector Y LSB	16	L, (-1) done in processor
150	4000086	Vector Y MSB	16	L, (-1) done in processor
152	4000088	Vector X LSB	16	D, (-1) done in processor
154	400008A	Vector X MSB	16	D, (-1) done in processor
156	400008C	Vector S LSB	16	
158	400008E	Vector S MSB	16	
160	4000090	Photo Det DC A	16	
162	4000092	Photo Det DC B	16	
164	4000094	Photo Det DC C	16	
166	4000096	Photo Det DC D	16	
168	4000098	Photo Det DC E	16	
170	400009A	Photo Det DC F	16	
172	400009C	Monitor Laser Current -	16	
174	400009E	Temp set after lock on	16	
176	40000A0	BPF out 430 MSB	16	
178	40000A2	BPF out 430 LSB	16	
180	40000A4	Boxcar out 430/860 MSB	16	
182	40000A6	Boxcar out 430/860 LSB	16	
184	40000A8	Integrator out 430/860 MSB	16	
186	40000AA	Integrator out 430/860 LSB	16	
188	40000AC	Acluster [15..0]	16	
190	40000AE	Bcluster [15..0]	16	
192	40000B0	Monitor Laser Current +	16	
194	40000B2	Monitor Laser Temp -	16	
196	40000B4	Monitor Laser Temp +	16	
198	40000B6	Open A/D Channel	16	
200	40000B8	Board Temperature	16	
202	40000BA	LaserBoxOut19k LSB	16	
204	40000BC	Tempclosedloop[31..16]	16	
206	40000BE	cnt[15..0]	16	
208	40000C0	he4dataA[0],GND[14..0]	16	
210	40000C2	he4dataA[16..1]	16	
212	40000C4	he4dataA[31],he4dataA[31..17]	16	
214	40000C6	he4dataB[0],GND[14..0]	16	
216	40000C8	he4dataB[16..1]	16	
218	40000CA	he4dataB[31],he4dataB[31..17]	16	
220	40000CC	system status bits	16	
222	40000CE	y-accel	16	T

Relative Base Address (bytes)	FPGA Address	Item	Size (bits)	Definition Units/LSB Value/Other
224	40000D0	19kerrorgained MSB	16	
226	40000D2	x-accel	16	L, (-1)
228	40000D4	9.5kerrorgained LSB	16	
230	40000D6	19kIntegOut MSB	16	
232	40000D8	LaserBoxOut19k MSB	16	
234	40000DA	9.5kIntegOut MSB	16	
236	40000DC	9.5kIntegOut LSB	16	
238	40000DE	lasercurrentdac[13..0]	16	
240	40000E0	photoagcd [26..11]	16	
242	40000E2	agccontrola LSB	16	
244	40000E4	agccontrola MSB	16	
246	40000E6	High Speed Data MSB	16	
248	40000E8	High Speed Data LSB	16	
250	40000EA	ToSubA LSB	16	
252	40000EC	ToSubA MSB	16	
254	40000EE	ToSubC LSB	16	
256	40000F0	19kIntegOut LSB	16	
258	40000F2	19kerrorgained LSB	16	
260	40000F4		16	
262	40000F6	ToSubC MSB	16	
264	40000F8		16	
266	40000FA	z-accel (not connected)	16	
268	40000FC	z-accel (digitized)	16	D
270	40000FE	Tempclosedloop[15..0]	16	

3.3.4 Format 3 – Sensor Compensation Control Data

Table 21 summarizes the message data layout for Format 3 which contains Sensor Compensation Control Data. The DT-704 Sensor holds an initial set of compensation parameters in non-volatile memory for use at power-on. A copy of the initial set is sent via a Format 3 message to the CP-2568 Computer/Power Supply (CPS) for recording. Revised Sensor Compensation Control Data Sets are sent from the CPS as they are developed in the CPS. Each Format 3 message from the CPS to the sensor is acknowledged by the sensor to the CPS via another Format 3 message.

Table 21 - Format 3 Sensor Compensation Control Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000011B
1	Reserved	24	TBD
4	Message Length	32	256
8	Source MSN	16	See Table 7 - Manufacturer Serial Number
10	Destination MSN	16	See Table 7 - Manufacturer Serial Number
12	Sample Count	32	1
16	T Perm Term	64	nT (DPFP)
24	L Perm Term	64	nT (DPFP)
32	D Perm Term	64	nT (DPFP)
40	TT Induced	64	(DPFP)
48	LL Induced N	64	(DPFP)
56	DD Induced E	64	(DPFP)
64	LT + TL Induced	64	(DPFP)
72	TD + DT Induced	64	(DPFP)
80	LD + DL Induced	64	(DPFP)
88	tt Eddy	64	(DPFP)
96	ll Eddy	64	(DPFP)
104	dd Eddy	64	(DPFP)
112	tl Eddy	64	(DPFP)
120	td Eddy	64	(DPFP)
128	lt Eddy	64	(DPFP)
136	ld Eddy	64	(DPFP)
144	dt Eddy	64	(DPFP)
152	dl Eddy	64	(DPFP)
160	Ave. He	64	nT (DPFP)
168	TBD	64	
176	TBD	64	
184	T Vector gain	64	(DPFP)
192	L Vector gain	64	(DPFP)
200	D Vector gain	64	(DPFP)
208	T Offset	64	nT (DPFP)
216	L Offset	64	nT (DPFP)

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
224	D Offset	64	nT (DPFP)
232	X Angle	64	degrees(DPFP)
240	Y Angle	64	degrees(DPFP)
248	Z Angle	64	degrees(DPFP)

3.3.5 Format 4 – System Control

Table 22 summarizes the message data layout for Format 4 which contains System Control Data.

Table 22 - Format 4 System Control

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000100B
1	Reserved	24	TBD
4	Message Length	32	240
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Sample Count	32	1
16	Modes/Command	32	See Mode/Command Decode
20	Bit Status	32	See Bit Status Decode
24	Aircraft Standard Turn Rate	64	Degrees/Sec (DPFP)
32	Search MSN	16	See 3.3.2.2
34	Reference MSN	16	See 3.3.2.2
36	Detection MSN	16	See 3.3.2.2
38	Relay MSN	16	See 3.3.2.2
40	System Status	32	See System Status Decode
44	Record/Playback Filename	512	Filename (See Note 11)
108	Retrieve Destination Filename	512	Filename (See Note 9)
172	Retrieve/Playback start Format	8	Designated Format ID
173	Retrieve/Playback start data point count	24	1 (Starting Data point count of Designated Format ID)
176	Noise Box Control	8	See 3.3.15.2 Noise Box Control Decode
177	Geology Processing Control	8	Start/Continue = 1, Stop = 0
178	Use Data File Valid	8	Flag saying if we should use the following data (1) or if we should use default parameters (0)
179	FFT power of 2	8	FFT size as a power of 2 ex: =9 then FFT size = 2^9 = 512
180	ANC L History Size	8	Tells how big the L history will be in terms of FFT size = integer multiple of the FFT size
181	(ANC L History)/(Coeff update rate)	8	Tells how often the L history will be updated in terms of FFT size = integer fractions of the FFT size
182	Ref Channels To Use	64	On/off flags for selecting which channels to use (See ENRAD Processing Channel Selection Table)
190	Gap Delay	8	1
191	FAR Type	8	CFAR or Fixed Threshold (2=fixed,1= cfar, 0 = default)
192	FAR Value	32	# of FAR per hour or the fixed level as a float

[11] Filename is from 1 to 63 ASCII characters long and is terminated by a null byte.

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
196	S1 Turn Indicator Threshold	32	For in turn out of turn threshold
200	S2 Turn Indicator Threshold	32	For in turn out of turn threshold
204	S3 Turn Indicator Threshold	32	For in turn out of turn threshold
208	Fixed Joint T thresh.	32	Fixed Threshold Joint Max T stat level for detector
212	Fixed MAD T thresh.	32	Fixed Threshold MAD Max T stat level for detector
216	Fixed ELF T thresh.	32	Fixed Threshold ELF Max T stat level for detector
220	Detector ELF start freq	32	single precision value for starting ELF frequency
224	Detector ELF end freq	32	single precision value for ending ELF frequency
228	Detector Update Rate	8	Detector update rate as a factor of how many calls per FFT block (<=NFFT & a power of 2)
229	PNR_Enabled	8	Pendulum Noise Reduction Control enabled =1, or disabled = 2, default = 2
230	PNR_refs	16	On/off flags for selection of reference channels for Fast Adaptive Pendulum Noise Reduction use. Defined in Table 27
232	PNR_Main	8	On/off flags for selection of Main channels for Fast Adaptive Pendulum Noise Reduction use. Defined in Table 28
233	PNR_ntaps	8	# of taps to use in the Fast Adaptive Pendulum Noise Reduction Algorithm (Default = 1)
234	PNR_taplength	16	# of data points per tap (min = 1 = default)
236	PNR_LHistorySize	16	# of data points in Fast Adaptive Pendulum Noise Reduction History (Default = 500)
238	No. of ELF Harmonics	8	Unsigned, Range 1<=x.=255, Default=1
239	No. of ELF Search Fundamentals	8	Unsigned, Range 2<=x<=255, Default=2

3.3.5.1 Mode/Command Decode for Format 4

Two options exist for the mode/command decode – Test Mode = 00(Binary) and Normal Mode = 01(Binary). Commands for both options are described in Table 23:

Table 23 - Format 4 Mode/Command Decode

Mode Bits 0,1	Command Code Value Bits 2-29	Command
00	1	No Test
00	2	Full System BIT
00	3	Test Processor Power Supply
00	4	Test Processor Board No. 1
00	5	Test Processor Board No. 2
00	6	Test Processor Board No. 3
00	7	Test Processor Board No. 4
00	8	Test All Processors
00	9	Test Processor to Sensor I/O
00	10	Test Processor Analog PWB
00	11	Test Sensor Processor
00	12	Test Sensor RLLC
00	13	Test Sensor Ignition
00	14	Test Sensor RF
00	15	Test Sensor Laser
00	16	Sensor BIT
00	17	Control BIT
00	18	Test Control Processor
00	19	Test Control Display
*	*	Undefined
01	50015	Undefined
01	50016	Normal Mode/All On
01	50017	Record On (See 3.3.5.2.1 Recording)
01	50018	Normal Mode/All Off
01	50019	Record Off (See 3.3.5.2.2 Retrieval)
01	50020	Format 1 Transmit On
01	50021	Format 2 Transmit On
01	50022	Format 3 Transmit On
01	50023	Format 4 Transmit On
01	50024	Format 5 Transmit On
01	50025	Format 6 Transmit On
01	50026	Format 7 Transmit On
01	50027	Format 8 Transmit On
01	50028	Format 9 Transmit On
01	50029	Format 10 Transmit On
01	50030	Format 11 Transmit On
01	50031	Format 12 Transmit On
01	50032	Format 13 Transmit On
01	50033	Format 14 Transmit On
01	50034	Format 15 Transmit On
01	50035	Format 16 Transmit Once
01	50075	Format 1 Transmit Off
01	50076	Format 2 Transmit Off

Mode Bits 0,1	Command Code Value Bits 2-29	Command
01	50077	Format 3 Transmit Off
01	50078	Format 4 Transmit Off
01	50079	Format 5 Transmit Off
01	50080	Format 6 Transmit Off
01	50081	Format 7 Transmit Off
01	50082	Format 8 Transmit Off
01	50083	Format 9 Transmit Off
01	50084	Format 10 Transmit Off
01	50085	Format 11 Transmit Off
01	50086	Format 12 Transmit Off
01	50087	Format 13 Transmit Off
01	50088	Format 14 Transmit Off
01	50089	Format 15 Transmit Off
01	50090	Undefined
01	*	*
01	50100	Learn Tolles and Lawson Coefficient set
01	50101	Apply Learned Tolles and Lawson Coefficient set
01	50102	Restore Default Tolles and Lawson Coefficient set
01	50103	Apply Geomagnetic Coefficients
01	50104	Apply Geology Coefficients
01	50105	Apply Buffeting Coefficients
01	50106	Processor Analog Outputs On
01	50107	Learn Adaptive Coefficients
01	50108	Synchronize Sensor Sampling (Reset)
01	50109	Auto Optimize Sensor
01	50110	Update Search/ Reference/ Detection Designation
01	50111	Playback Mode Operator Control
01	50112	Playback Mode Data Control
01	50113	Retrieve Data to Display Processor
01	50114	Delete File “Filename”
01	50115	Retrieve Directory Listing
01	50116	Dual Sensor Tracker Input
01	50117	Single Sensor Tracker Input
*	50118	Undefined
*	*	*
*	*	Undefined

3.3.5.2 Recording and Retrieving

3.3.5.2.1 Recording

Upon power-up, the CPS connects with the attached sensor, the associated Display Control Processor (DCP), and the associated CPS. Once connected, the CPS will begin receiving Format 1 messages from the sensor. All message traffic will be recorded under filename “Startup1” or, alternatively, “Startup2” in the PBOD flash memory. When the sensor’s GPS unit has achieved “fine steering” mode, the CPS will acquire the current data/time from the first MarkPosb log in a Format 1 message reporting the fine steering mode. The CPS will use the date/time obtained as the seed value for its internal clock, Upon establishment of the internal clock, the CPS will define a session recording filename to be the value of the

initial clock setting of the form (YearMonthDayHourMinuteSecond –yyyyMMddhhmmss). The file is to be established under a directory name of “Data” within the PBOD and all data stored in the Startup(1/2) file is to be transferred into the front of the newly created file with all subsequent messages stored in the file after the Startup(1/2) records. A Format 4 message with the path/filename in the “Record/Playback Filename” field is to be sent to the DCP with the command mode value of “50017 – Record On.” All subsequent message traffic to or from CPS Control is to be recorded in the named file until command is received from the DCP to “50019 - Record Off,” whereupon the CPS will close the file, stop recording, and acknowledge the Format 4 command to the DCP. Any subsequent command from the DCP to “Set Record ON” will cause the creation of a new file under a name drawn from the, then, current date/time of the CPS clock and placed in the PBOD directory name of “Data”.

3.3.5.2.2 Retrieval

The DCP is to maintain, on a general status window, the name of the file to which data is currently being recorded. (The DCP should maintain a restart file of the currently active commands and other pertinent system execution parameters that are for resumption of execution should the DCP be stopped unintentionally. The DCP should have a shutdown mode that clears the file. Upon startup, the DCP should check the file and, if the file is still valid, use it to resume operation. If the file is not valid, proceed with initial setup.) When the operator enters a retrieve command to the DCP, the DCP is to request an updated Format 13 Recorded File Directory Readout, format it for display in windows organized by directory folder for the operator to select the files to be retrieved. The DCP will, then, issue retrieve commands for that/those files to the operator designated root folder of the DCP and notify the operator of the progress and completion of the retrieval.

3.3.5.3 BIT Status Decode for Format 4

Table 24 - Format 4 BIT Status Decode

Bit Test Value (Binary)	Definition Units/LSB Value/Other
00000000000000000000000000000000	**No Fail**
00000000000000000000000000000001	System Fail
00000000000000000000000000000010	Computer/Power Supply Fail
00000000000000000000000000000100	Processor Board No. 1 Fail
00000000000000000000000000001000	Processor Board No. 2 Fail
00000000000000000000000000010000	Processor Board No. 3 Fail
00000000000000000000000000100000	Processor Board No. 4 Fail
00000000000000000000000001000000	Processor to Sensor I/O Fail
00000000000000000000000010000000	Processor Analog PWB Fail
00000000000000000000000100000000	Sensor Processor Fail
00000000000000000000001000000000	Sensor RLLC Fail
00000000000000000000010000000000	Sensor Ignition Fail
00000000000000000000100000000000	Sensor RF Fail
00000000000000000001000000000000	Sensor Laser Fail
00000000000000000010000000000000	Sensor LRU Fail
00000000000000000100000000000000	Control LRU Fail
00000000000000001000000000000000	Control Processor Fail
00000000000000010000000000000000	Control Display Fail
00000000000000100000000000000000	Noise Reduction/Detection Initialization Fail

3.3.5.4 System Status-

Table 25 defines the elements of System Status Information output to the Display/Control Processor by the Detection Computer Power Supply (CPS) provided in Format 4. This Status Summary is output every time one of the indicated Status Parameters changes or whenever the Operator commands a change in activity by sending a Format 4 message to a CPS.

Table 25 - Format 4 System Status

System Status			
Sub-Field Alignment 0----------31	**Item**	**Size (in bits)**	**Definition Units/LSB Value/Other**
0	Reset Status	2	Reset Status Code 0 = No Reset Active 1 = Reset in Progress 2 = Reset Complete 3 = Reset Fail
2	Search Sensor/ Reference Sensor Time Drift	2	Sensor Time Drift Range 0 = <= Threshold 0 (Green) 1 = <= Threshold 1 (Blue) 2 = <= Threshold 2 (Yellow) 3 = <= Threshold 3 (Red)
4	System Configuration Defined	1	0 = False 1 = True
5	Recording On	1	0 = False 1 = True
6	Recording to Named File	1	0 = False 1 = True
7	Format 4 Message Count Reset	1	0 = False 1 = True
8	Search Sensor Sample Count Error	1	0 = False 1 = True
9	Reference Sensor Sample Count Error	1	0 = False 1 = True
10	Search Sensor Data Stopped	1	0 = False 1 = True
11	Reference Sensor Data Stopped	1	0 = False 1 = True
12	Error – Designated Record File Name Already Exists	1	0 = False 1 = True
13	Noise Box in Process	1	0 = False 1 = True
*	Not Yet Defined	1	
*	Not Yet Defined	1	
31	Not Yet Defined	1	

3.3.5.5 Processing Channel Selection Table

Table 26 provides description of the table for specifying selection of Noise Reduction and Detection processing channels for execution within the CP-2569 Computer Power Supply. This definition is placed in a Format 4 System Control message and transmitted to the Computer Power Supply where it is translated to a Format 15 Noise Reduction/Detection Processing Control message and sent to be delivered to the Environmental Noise Reduction and Detection (ENRAD module.

Table 26 ENRAD Processing Channel Selection Table

Ref Channel Selection Decode		
Sub-Field Alignment 0----------63	Channel	**Definition Units/LSB Value/ Other**
0	Search VMT	0=off,1=on
1	Search VML	0=off,1=on
2	Search VMD	0=off,1=on
3	Search ACT	0=off,1=on
4	Search ACL	0=off,1=on
5	Search ACD	0=off,1=on
6	Search Vertical Velocity	0=off,1=on
7	Search S1	0=off,1=on
8	Search S2	0=off,1=on
9	Search S3	0=off,1=on
10	Search S4	0=off,1=on
11	Search S5	0=off,1=on
12	Search S6	0=off,1=on
13	Search S7	0=off,1=on
14	Search S8	0=off,1=on
15	Search S9	0=off,1=on
16	Search S10	0=off,1=on
17	Search S11	0=off,1=on
18	Search S12	0=off,1=on
19	Search S13	0=off,1=on
20	Search S14	0=off,1=on
21	Search S15	0=off,1=on
22	Search S16	0=off,1=on
23	Search *Bestpos* Altitude	0=off,1=on
24	Search Horizontal Speed	0=off,1=on
25	Search Heading	0=off,1=on
26	undefined	0=off,1=on
27	undefined	0=off,1=on
28	undefined	0=off,1=on
29	undefined	0=off,1=on
30	undefined	0=off,1=on
31	undefined	0=off,1=on
32	Reference UTF	0=off,1=on
33	Reference VMT	0=off,1=on
34	Reference VML	0=off,1=on
35	Reference VMD	0=off,1=on

Ref Channel Selection Decode		
Sub-Field Alignment 0----------63	Channel	**Definition Units/LSB Value/ Other**
36	Reference ACT	0=off,1=on
37	Reference ACL	0=off,1=on
38	Reference ACD	0=off,1=on
39	Reference Vertical Velocity	0=off,1=on
40	Reference S1	0=off,1=on
41	Reference S2	0=off,1=on
42	Reference S3	0=off,1=on
43	Reference S4	0=off,1=on
44	Reference S5	0=off,1=on
45	Reference S6	0=off,1=on
46	Reference S7	0=off,1=on
47	Reference S8	0=off,1=on
48	Reference S9	0=off,1=on
49	Reference S10	0=off,1=on
50	Reference S11	0=off,1=on
51	Reference S12	0=off,1=on
52	Reference S13	0=off,1=on
53	Reference S14	0=off,1=on
54	Reference S15	0=off,1=on
55	Reference S16	0=off,1=on
56	Reference *Bestpos* Altitude	0=off,1=on
57	Reference Horizontal Speed	0=off,1=on
58	Reference Heading	0=off,1=on
59	undefined	0=off,1=on
60	undefined	0=off,1=on
61	undefined	0=off,1=on
62	undefined	0=off,1=on
63	undefined	0=off,1=on

3.3.5.6 Fast Adaptive Pendulum Noise Reduction Reference Channel Selection Table

Table 27 provides description of the table for specifying selection of Main processing channels for use by the Fast Adaptive Pendulum Noise Reduction Algorithm within the CP-2569 Computer Power Supply. These selections are placed in a Format 4 System Control message and transmitted to the Computer Power Supply where it is translated to a Format 15 Noise Reduction/Detection Processing Control message and sent to be delivered to the Environmental Noise Reduction and Detection (ENRAD module.

Table 27 Fast Adaptive Pendulum Noise Reduction Reference Channel Selection Options

Fast Adaptive Pendulum Noise Reduction **Reference Channel Selection**		
Sub-Field Bit Alignment 0----------15	Channel	**Definition Units/LSB Value/ Other**
0	Undefined	0=off,1=on
1	Reference Sensor S3	0=off,1=on
2	Reference Sensor S2	0=off,1=on
3	Reference Sensor S1	0=off,1=on

Fast Adaptive Pendulum Noise Reduction **Reference Channel Selection**		
Sub-Field Bit Alignment 0----------15	Channel	**Definition Units/LSB Value/ Other**
4	Reference Sensor Heading	0=off,1=on
5	Reference Sensor Horizontal Velocity	0=off,1=on
6	Reference Sensor Vertical Velocity	0=off,1=on
7	Reference Sensor UTF	0=off,1=on
8	Undefined	0=off,1=on
9	Undefined	0=off,1=on
10	Search Sensor S3	0=off,1=on
11	Search Sensor S2	0=off,1=on
12	Search Sensor S1	0=off,1=on
13	Search Sensor Heading	0=off,1=on
14	Search Sensor Horizontal Velocity	0=off,1=on
15	Search Sensor Vertical Velocity	0=off,1=on

3.3.5.7 Fast Adaptive Pendulum Noise Reduction Algorithm Main Channel Selection Table

Table 28 provides description of the table for specifying selection of Main processing channels for use by the Fast Adaptive Pendulum Noise Reduction Algorithm within the CP-2569 Computer Power Supply. These selections are placed in a Format 4 System Control message and transmitted to the Computer Power Supply where it is translated to a Format 15 Noise Reduction/Detection Processing Control message and sent to be delivered to the Environmental Noise Reduction and Detection (ENRAD module.

Table 28 Fast Adaptive Pendulum Noise Reduction Main Channel Selection

Fast Adaptive Pendulum Noise Reduction **Main Channel Selection**		
Sub-Field Bit Alignment 0----------7	**Channel**	**Definition Units/LSB Value/ Other**
0	Undefined	0=off,1=on
1	Undefined	0=off,1=on
2	Undefined	0=off,1=on
3	Undefined	0=off,1=on
4	Undefined	0=off,1=on
5	ENRAD Noise Reduced UTF	0=off,1=on
6	Search Sensor Filtered UTF	0=off,1=on
7	Search Sensor Unfiltered UTF	0=off,1=on, Default = 1

3.3.6 Format 5 – Pre-Mapped Target Data (Future Growth)

The following table summarizes the message data layout for Format 5 which contains Pre-Mapped Target Data. This format is not planned to be incorporated into the 3MDS Execution Phase, but is defined here for future implementation.

Table 29 - Format 5 Pre-Mapped Target Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000101B
1	Reserved	24	TBD
4	Message Length	32	72
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Sample Count	32	1
16	Number of Targets	32	1
20	Target Number 1	32	00000001H
24	Target Latitude	64	degrees(DPFP)
32	Target Longitude	64	degrees(DPFP)
40	Target Depth	64	degrees (DPFP)
48	North Moment	64	degrees (DPFP)
56	East Moment	64	degrees (DPFP)
64	Vertical Moment	64	degrees (DPFP)
	See Note 12		

[12] The Pre-Mapped Target Data message contains the “Number of Targets” sets of target definitions each containing [Target Number, Target Latitude, Target Longitude, Target Depth, North Moment, East Moment, and Vertical Moment] as defined here. A single Pre-Mapped Target Data message may be succeeded by additional Pre-Mapped Target Data messages with more target definitions to be added to the Pre-Mapped Target Data Table.

3.3.7 Format 6 – False Target Data Output (Future Growth)

The following table summarizes the message data layout for Format 6 which contains World Magnetic Model Data. This format is not planned to be incorporated into the 3MDS Execution Phase, but is defined here for future implementation.

Table 30 - Format 6 False Target Data Output

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000110B
1	Reserved	24	TBD
4	Message Length	32	72
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Sample Count	32	1
16	Number of Dipoles	32	1
20	Dipole Number 1	32	00000001H
24	Dipole Latitude	64	degrees (DPFP)
32	Dipole Longitude	64	degrees (DPFP)
40	Dipole Depth	64	degrees (DPFP)
48	North Moment	64	degrees (DPFP)
56	East Moment	64	degrees (DPFP)
64	Vertical Moment	64	degrees (DPFP)
	See Note 13		

[13] The False Target Data Output message contains the “Number of Dipole” sets of false target definitions each containing [Dipole Number, Dipole Latitude, Dipole Longitude, Dipole Depth, North Moment, East Moment, and Vertical Moment] as defined here. A single False Target Data Output message may be succeeded by additional False Target Data Output messages with more target definitions to be added to the False Target Data Table.

3.3.8 Format 7 – Track Data

The following table summarizes the message data layout for Format 7 which contains Track Data output by the MAD Tracker function generated from operator selected detection information.

Table 31 - Format 7 Track Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00000111B
1	Reserved	24	TBD
4	Message Length	32	212
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Sample Count	32	1
16	CPA Time 1	64	Earliest selected CPA Time; Seconds since midnight start of mission day GMT (DPFP)
24	CPA Time 2	64	Latest selected CPA Time; Seconds since midnight start of mission day GMT (DPFP)
32	Latitude	64	degrees(DPFP)
40	Longitude	64	degrees(DPFP)
48	Depth	64	feet(DPFP)
56	Velocity	64	Knots (DPFP)
64	Heading	64	degrees (DPFP)
72	North Dipole Moment	64	nT –ft^3 (DPFP)
80	East Dipole Moment	64	nT –ft^3 (DPFP)
88	Vertical (down) Dipole Moment	64	nT –ft^3 (DPFP)
96	HED Moment	64	Amp-Meter (DPFP)
104	ELF Moment	64	Amp-Meter (DPFP)
112	ELF Frequency	64	Hertz (DPFP)
120	Reserved for Future Capability	64	
128	Reserved for Future Capability	64	
136	Reserved for Future Capability	64	
144	Reserved for Future Capability	64	
152	Reserved for Future Capability	64	
160	Reserved for Future Capability	64	
168	Reserved for Future Capability	64	
176	Reserved for Future Capability	64	
184	Reserved for Future Capability	64	
192	Reserved for Future Capability	64	
200	Reserved for Future Capability	64	
208	Tracker Status	32	See Table 32 Format 7 Tracker Status Decode

Table 32 Format 7 Tracker Status Decode

System Status			
Sub-Field Alignment 0----------31	**Item**	**Size (in bits)**	**Definition Units/LSB Value/Other**
0	Tracker Result Confidence Status	2	Tracker Result Status Code[14] 0 = No Confidence 1 = Low Confidence 2 = Medium Confidence 3 = High Confidence
2	Full Column Rank	1	0 = False 1 = True
3	Convergence	1	0 = False 1 = True
4	Depth Test	1	0 = Fail 1 = Pass
5	Speed Test	1	0 = Fail 1 = Pass
6	Dipole Moment Test	1	0 = Fail 1 = Pass
7	First Estimated CPA Range Test	1	0 = Fail 1 = Pass
8	Second Estimated CPA Range Test	1	0 = Fail 1 = Pass
9	HED total moment Test	1	0 = Fail 1 = Pass
10	NRTD or CTF Used for Track Calculation	1	0 = NRTD (Noise Reduced Time Domain) 1 = CTF (Compensated Total Field)
11	CPA1 Invalid	1	0 = False, 1 = True[15]
12	CPA2 Invalid	1	0 = False, 1 = True[15]
13	Not Yet Defined		
*			
*			
31	Not Yet Defined	1	

[14] 0 = No Confidence (Full Column Rank=False)
1 = Low Confidence (Full Column Rank=True, but does not meet High or Medium Confidence Criteria)
2 = Medium Confidence (Full Column Rank=True, Four other tests=Pass) or (Full Rank Convergence=False, All Tests Pass)
3 = High Confidence (Full Rank=True,Convergence=True,All tests=Pass)

[15] Either CPA found to be invalid precludes generation of a Track solution, and, therefore, none of the track output fields will contain valid data.

3.3.9 Format 8 – Detection Data

The following table summarizes the message data layout for Format 8 which contains Detection Data.

Table 33 - Format 8 – Detection Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00001000B
1	Reserved	24	TBD
4	Message Length	32	96
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Detection Flag	8	>3 = Not Assigned 3 = Joint Detection 2 = MAD Detection 1 = ELF Detection 0 = No Detection
17	Format 8 Detection Data Status	24	See Format 8 Detection Status Decode
20	Reserved	32	TBD
24	GPS Time for detection data	64	Seconds since midnight start of mission day GMT (DPFP)
32	GPS Latitude for Detection Data	64	Degrees (DPFP)
40	GPS Longitude for Detection Data	64	Degrees (DPFP)
48	GPS Height above mean sea level for Detection Data	64	Meters (DPFP)
56	Joint Detection Level (See Note 16)	64	Range ($-1,1x10^6$) (DPFP)
64	MAD Detection Level (See Note 12)	64	Range ($-1,1x10^6$) (DPFP)
72	ELF Detection Level (See Note 12)	64	Range ($-1,1x10^6$) (DPFP)
80	Slant Range	64	Ft. (DPFP)
88	ELF Frequency Estimate	64	Hertz (DPFP)

[16] Detection levels are representations of T-statistic values for declaring detection strength.

Table 34 Format 8 Detection Status Decode

Subfield Alignment 0----------23	Field Name	**Definition Units/LSB Value/Other**
0	Data Valid	0 = Not Valid 1 = Valid
1	Format 8 Message Count Reset	0 = Not Reset 1 = Reset
2	Not Assigned	N/A
22	Not Assigned	N/A
23	Turn in Progress Detected	0 = Not Detected 1 = Detected

3.3.10 Format 9 – Time Domain Detection Data

The following table summarizes the message data layout for Format 9 which contains Time Domain Detection Data.

Table 35 - Format 9 Time Domain Noise Reduced Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00001001B
1	Reserved	24	TBD
4	Message Length	32	48
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Format 9 Status	32	See Format 9 Status Decode
20	Sample Count for time domain point	32	1
24	GPS Time for time domain pt	64	Seconds since midnight start of mission day GMT (DPFP)
32	Noise Reduced Time Domain Value	64	nT (DPFP)
40	Compensated Total Field Value	64	nT (DPFP)[17]

[17] The Compensated Total Field Values from the Search Sensor Format 1 messages decimated to 10 Hz and filtered.

Table 36 Format 9 Status Decode

Subfield Alignment 0----------32	Field Name	**Definition Units/LSB Value/Other**
0	Format 9 Data Valid	0 = Not Valid 1 = Valid
1	Format 9 Message Count Reset	0 = Not Reset 1 = Reset
2	Single Sensor/Dual Sensor Selection	0 = Single Sensor 1 = Dual Sensor
3	Sample Value Interpolated[18]	0 = No interpolation 1 = Value interpolated
	Not Assigned	N/A
15	Noise Box/Detection Result	0 = Detection Result 1 = Noise Box Result
*	"	"
32	Not Assigned	N/A

[18] When in Dual Sensor Mode (Status Bit 2 = 1) and data from the Reference Sensor is not available for less than 1 (one) second, the missing values are estimated through interpolation to minimize impact from short data dropout.

Format 10 – Frequency Domain Noise Reduced Data

The following table summarizes the message data layout for Format 10 which contains real-valued Power Spectral Density data in arrays for frequency bins from dc to the Nyquist frequency. The size of each array, in number of points, is defined by the message parameter Number of Frequency Domain Points. The maximum number of points for each array that will be delivered in a Format 10 message is 1025 and, therefore, the largest value that will be assigned to the Number of Frequency Domain Points parameter is 2048.

Table 37 - Format 10 Frequency Domain Real-Time Noise Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00001010B
1	Reserved	24	TBD
4	Message Length	32	See Note[19]
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Data Valid	8	See Table 38 Format 10 Data Valid Decode
17	Alignment Spare	56	0
24	Number of Frequency Domain Points (NFFT)	32	1
28	Sample Count for newest time in FFT array	32	1
32	GPS Time for newest time in FFT array	64	Seconds since midnight start of mission day GMT (DPFP)
40	Decimated Sampling Frequency (sampling frequency of FFT data)	64	Hz (DPFP)
48	Noise Reduced Frequency Domain Value (1) (See Note 20)	64	nT^2/Hz (DPFP)
	. .		
48 + (((NFFT/2) +1)-1)*8	Noise Reduced Frequency Domain Value (NFFT/2+1)	64	nT^2/Hz (DPFP)
48 + ((NFFT/2)+ 1)*8	Motion Noise Reduced Frequency Domain Value (1) from the Sensor (After decimation) (See Note 21)	64	nT^2/Hz (DPFP)

[19] Format 10 Message length is variable relative to the value of NFFT, the number of points used in FFT computation. For any given Format 10 message, the length is determined by the equation
Len = 48 +((NFFT/2)+1)*8+((NFFT/2)+1)*8

[20] Noise Reduced Frequency Domain data = ENRAD Frequency Domain Total Field Output (noise reduced data)

[21] Motion Noise Reduced Frequency Domain Data = ENRAD Frequency Domain Input Total Field (derived from either the CTF or UTFa field from format 1 - after LPF, decimation, and HPF).

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
	. .		
48 + ((NFFT/2)+1)*8 + (((NFFT/2)+1)-1)*8	Motion Noise Reduced Frequency Domain Value ((NFFT/2)+1) from the Sensor (After decimation)	64	nT^2/Hz (DPFP)

Table 38 Format 10 Data Valid Decode

Subfield Alignment 0----------7	Field Name	**Definition** **Units/LSB Value/Other**
0	Noise Box/Detection Result	0 = Detection Result 1 = Noise Box Result
1	Not Assigned	N/A
2	Not Assigned	N/A
3	Not Assigned	N/A
4	Not Assigned	N/A
5	Not Assigned	N/A
6	Not Assigned	N/A
7	Format 10 Data Valid	0 = Not Valid 1 = Valid

3.3.11 Format 11 – High Speed Debug Data

The following table summarizes the message data layout for Format 11 which contains High Speed Debug Data transmitted at 37878.7988 Hz. High Speed Debug Data is reserved for sensor test and diagnosis and is not used in normal operation.

Table 39 - Format 11 High Speed Debug Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00001011B
1	Data Point Count	24	8
4	Selectable by FPGA program	32	TBD

3.3.12 Format 12 – Start/End Playback/Retrieve

Table 40 defines the format and content of the system message that bounds recorded data that is being reprocessed through Playback, or Retrieved to the Display/Control Processor for archive or external processing. After a Format 4 message containing a command to enter Playback Mode is received by a Computer/Power Supply, execution of the command begins with a Format 12 message set to Start, and completes with a Format 12 message set to End. Format 12 messages may be sent to any system components involved in the Playback/Retrieve operation, but are definitely sent to the commanding Display/Control Processor.

Table 40 - Format 12 Start/End Playback/Retrieve

Start-End Playback/Retrieve			
Byte Offset	**Item**	**Size (bits)**	**Definition Units/LSB Value/Other**
0	ID	8	00001100B
1	Reserved	24	TBD
4	Message Length	32	18
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Playback/Retrieve	8	00H/01H
17	Start/End	8	00H/01H

3.3.13 Format 13 – Recorded File Directory Listing

Table 41 defines the format and content of the system control message that is sent in response to the Format 4 command to retrieve stored filenames and sizes to the Display/Control Processor. The filenames are sent in "blocks" of 10 filenames in a Format 13 message with the "Block Number of Filename Block" incremented by 1 with each message.

Table 41 - Format 13 Recorded File Directory Readout

Recorded File Directory Readout			
Byte Offset	**Item**	**Size (bits)**	**Definition Units/LSB Value/Other**
0	ID	8	00001101B
1	Reserved	24	TBD
4	Message Length	32	Variable : 20+(N-1)*72 +8
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Number of Filenames (n)	16	1
18	Block Number of Filename Block	16	1
20	Filename 1	512	Filename Note
84	File Size in Bytes	64	1
:	:	:	:
20+(N-1)*72	Filename N	512	Filename Note
20 +(N-1)*72 +8	File Size in Bytes	64	1

3.3.14 **Format 14 –** Message Recording Wrapper

Table 41 defines the format and content of the message wrapper that is used to encapsulate each message recorded by the Record/Playback/Retrieve function in response to the Format 4 command to begin storing message data.

Table 42 - Format 14 Message Recording Wrapper

Message Recording Wrapper			
Byte Offset	**Item**	**Size (bits)**	**Definition Units/LSB Value/Other**
0	ID	8	00001110B
1	Reserved	24	TBD
4	Message Length	32	Variable : 20+Content Message Length-1
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Content Message ID	8	MSG ID
17	Content Message Length N (bytes)	24	1
20	MSG Byte 1	8	First byte of Message
:	:	:	:
20+Content Message Length-1	MSG Byte N	8	Last Byte of Message

3.3.15 Format-15 Noise Reduction/Detection Processing Control

Table 49 defines the format and content of the message that conveys control direction to the Noise Reduction and Detection Processing functions. This message is derived from the Format 4 message sent from the Display/Control Processor to the Computer/Power Supply. Format 15 messages are sent to the function calling the Noise Reduction and Detection processes where the message is delivered in the call with the Data Valid item set to "Valid."

Table 43 - Format-15 Noise Reduction/Detection Processing Control

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00001111B
1	Reserved	24	TBD
4	Message Length	32	96
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Data Valid	16	1 = Valid, 0 = Invalid
18	Mode/Command	16	See Mode/Command Decode
20	Bit Status	32	See Bit Status Decode
24	Aircraft Standard Turn Rate	64	Degrees/Sec (DPFP)
32	Noise Box Control	8	Start/Continue = 1, Stop = 0
33	Geology Processing Control	8	Start/Continue = 1, Stop = 0
34	Use Data File Valid	8	Flag saying if we should use the following data (1) or if we should use default parameters (0)
35	FFT power of 2	8	FFT size as a power of 2 ex: =9 then FFT size = 2^9 = 512
36	ANC L History Size	8	Tells how big the L history will be in terms of FFT size = integer multiple of the FFT size
37	(ANC L History)/(Coeff update rate)	8	Tells how often the L history will be updated in terms of FFT size = integer fractions of the FFT size
38	Ref Channels To Use	64	On/off flags for selecting which channels to use - see decode for more info (See Table 26 ENRAD Processing Channel Selection Table)
46	Gap Delay	8	1
47	FAR Type	8	CFAR or Fixed Threshold (2=fixed,1= cfar, 0 = default)
48	FAR Value	32	# of FAR per hour or the fixed level as a float
52	S1 Turn Indicator Threshold	32	For in turn out of turn threshold
56	S2 Turn Indicator Threshold	32	For in turn out of turn threshold
60	S3 Turn Indicator Threshold	32	For in turn out of turn threshold

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
64	Fixed Joint T thresh.	32	Fixed Threshold Joint Max T stat level for detector
68	Fixed MAD T thresh.	32	Fixed Threshold MAD Max T stat level for detector
72	Fixed ELF T thresh.	32	Fixed Threshold ELF Max T stat level for detector
76	Detector ELF start freq	32	single precision value for starting ELF frequency
80	Detector ELF end freq	32	single precision value for ending ELF frequency
84	Detector Update Rate	8	Detector update rate as a factor of how many calls per FFT block (<=NFFT & a power of 2)
85	PNR_Enabled	8	Pendulum Noise Reduction Control enabled = 1 or disabled = 2 default = 2
86	PNR_refs	16	On/off flags for selection of reference channels for Fast Adaptive Pendulum Noise Reduction use. Defined in Table 27
88	PNR_Main	8	On/off flags for selection of Main channels for Fast Adaptive Pendulum Noise Reduction use. Defined in Table 28
89	PNR_ntaps	8	# of taps to use in the Fast Adaptive Pendulum Noise Reduction Algorithm (Default = 1)
90	PNR_taplength	16	# of data points per tap (min = 1 = default)
92	PNR_LHistorySize	16	# of data points in Fast Adaptive Pendulum Noise Reduction History (Default = 500)
94	No. of ELF Harmonics	8	Unsigned, Range 1<=x.=255, Default=1
95	No. of ELF Search Fundamentals	8	Unsigned, Range 2<=x<=255, Default=2

3.3.15.1 Mode/Command Decode for Format 15

Three options exist for the mode/command decode – Test Mode, Normal Mode, and Playback Mode. All three options are described in the following subparagraphs:

3.3.15.1.1 Option 1 – Test Mode

Table 44 -– Format 15 Mode/Command Decode Option 1 - Test Mode

Mode/Command Value (Binary)	Definition Units/LSB Value/Other
00xxxxxxxxxxxxx	**Test Mode**
0000000000000000	No Test
0000000000000001	Test in Progress

3.3.15.1.2 Option 2 – Normal Mode

Table 45 -– Format 15 Mode/Command Decode Option 2 - Normal Mode

Mode/Command Value (Binary)	Definition Units/LSB Value/Other
01xxxxxxxxxxxxx	**Normal Mode**
0100000000000000	Normal Mode/All Off
0100000000000001	Normal Mode On
0100000000001000	Synchronize Sensor Sampling (Reset)
0100000001000000	Clear/Restart Processing History

3.3.15.1.3 Option 3 – Playback Mode

Table 46 -– Format 15 Mode/Command Decode Option 3 - Playback Mode

Mode/Command Value (Binary)	Definition Units/LSB Value/Other
11xxxxxxxxxxxxx	**Playback Mode**
1100000000000000	Playback Mode Operator Control
1100000000000001	Playback Mode Data Control
1100000000001000	Synchronize Sensor Sampling (Reset)
1100000001000000	Clear/Restart Processing History

3.3.15.2 Noise Reduction and Detection Processing Control

In order to provide operator control over Noise Reduction and Detection (NRD) Processing during operational testing, a number of parameters and switch fields are included in the Display Control Processor Operator Window Tabs and to Format 4 for transmission to the processing elements. These fields are defined starting with Relative Base Address 176 - Noise Box Control of Table 22 and continuing through Relative Base Address 237 – Reserved for Future Use.

There are three distinct control functions provided by these parameters:

a. Provide initialization values for processing array sizes and computational terms,

b. Direct the acquisition of new or previously collected “Noise Box Data” to facilitate the Noise Reduction process,

c. Adjust threshold and other control parameters during test execution.

In order to accomplish these three control functions, an initial set of the parameters is to be provided to the NRD processing program's initialization function prior to any noise reduction or detection processing can begin. Noise Box data source selection has additional activation control to separate Noise Box data processing from normal NRD processing, and the full set of NRD parameters are provided and updated to NRD after the initialization operation designation.

Thus, NRD is not initialized for processing until the operator actively changes the Use Data File Valid control to either "Use Default" (0) or "Use Following" (1) from its default setting of "Not set by operator" (3). No Format 1 sensor data is provided to NRD until both a) NRD has been initialized, and b) the operator designates "Noise Box Control Active" (1) along with "Noise Box Selection" set to either "Start" (1), or "Previous" (2).

If Noise Box Collect is set to "Start" (1). Noise Box Control Active is set to "Yes" (1), and initialization has been completed, Format 1 data will be provided to NRD for Noise Box Data processing and the same Format 1 data will be recorded for use on later tests under operator direction. This Format 1 data will also be recorded with all other messages in the full data recording file. The Noise Box collection period continues until the operator changes Noise Box Collect to Stop = 0, whereupon the recording of the Noise Box data will be closed, NRD will be commanded to Stop Noise Box Collection, and current Format 1 sensor data will be sent to NRD for processing.

If Noise Box Collect is set to "Previous" (2), NRD has been initialized, and Noise Box Control Active is set to "Yes" (1), a Noise Box Collect set to "Start" (1) will be sent to NRD in a Format 15 message by Computer Power Supply (CPS) Control. CPS Control will, then, read the stored Format 1 Noise Box data from the previously recorded file and provide it to NRD as quickly as NRD can accept it. This Format 1 data will also be recorded with all other messages in the full data recording file. When the last pre-recorded Format 1 Noise Box Data message has been provided to NRD, a Format 15 message commanding Noise Box Collect to "Stop" (0) will be provided to NRD. CPS Control will, the, direct the current Format 1 sensor data being received from the sensor(s) to be provided to NRD for processing.

Other NRD control parameters may be updated by the operator at any time on the display tab and directed to be sent to NRD during processing.

3.3.15.3 Noise Box Control Decode

The Noise Box Control consists of two sub-fields in an eight bit field.

Table 47 - Noise Box Control Decode

```
 0    0    0    0    0    0    0    0

 |              |              |____|
 |              |                 | - Noise Box Collect
 |              |                       0 = Stop
 |              |                       1 = Start
 |              |                       2 = Previous
 |              |                       2 = Default
 |              | - Detection Processing Control
 |                             0 = Stop
 |                             1 = Start
 |                             0 = Default
 |
 | - Noise Box Control Active
   0 = No
   1 = Yes
   0 = Default
```

3.3.15.4 Processing Channel Selection Table

Table 26 provides a description of the table for specifying selection of Noise Reduction and Detection processing channels for execution within the CP-2569 Computer Power Supply. This definition is placed in a Format 4 System Control message and transmitted to the Computer Power Supply where it is translated to a Format 15 Noise Reduction/Detection Processing Control message and sent to be delivered to the Environmental Noise Reduction and Detection (ENRAD) module.

Table 48 - ENRAD Processing Channel Selection Table

Ref Channel Selection Decode		
Sub-Field Alignment **0----------63**	Channel	0=off,1=on
0	Search VMT	0=off,1=on
1	Search VML	0=off,1=on
2	Search VMD	0=off,1=on
3	Search ACT	0=off,1=on
4	Search ACL	0=off,1=on
5	Search ACD	0=off,1=on
6	Search Vertical Velocity	0=off,1=on
7	Search S1	0=off,1=on
8	Search S2	0=off,1=on
9	Search S3	0=off,1=on
10	Search S4	0=off,1=on
11	Search S5	0=off,1=on
12	Search S6	0=off,1=on
13	Search S7	0=off,1=on
14	Search S8	0=off,1=on
15	Search S9	0=off,1=on
16	Search S10	0=off,1=on
17	Search S11	0=off,1=on
18	Search S12	0=off,1=on
19	Search S13	0=off,1=on
20	Search S14	0=off,1=on
21	Search S15	0=off,1=on
22	Search S16	0=off,1=on
23	Search *Bestpos* Altitude	0=off,1=on
24	Search Horizontal Speed	0=off,1=on
25	Search Heading	0=off,1=on
26	undefined	0=off,1=on
27	undefined	0=off,1=on
28	undefined	0=off,1=on
29	undefined	0=off,1=on
30	undefined	0=off,1=on
31	undefined	0=off,1=on
32	Reference UTF	0=off,1=on
33	Reference VMT	0=off,1=on
34	Reference VML	0=off,1=on
35	Reference VMD	0=off,1=on
36	Reference ACT	0=off,1=on
37	Reference ACL	0=off,1=on

38	Reference ACD	0=off,1=on
39	Reference Vertical Velocity	0=off,1=on
40	Reference S1	0=off,1=on
41	Reference S2	0=off,1=on
42	Reference S3	0=off,1=on
43	Reference S4	0=off,1=on
44	Reference S5	0=off,1=on
45	Reference S6	0=off,1=on
46	Reference S7	0=off,1=on
47	Reference S8	0=off,1=on
48	Reference S9	0=off,1=on
49	Reference S10	0=off,1=on
50	Reference S11	0=off,1=on
51	Reference S12	0=off,1=on
52	Reference S13	0=off,1=on
53	Reference S14	0=off,1=on
54	Reference S15	0=off,1=on
55	Reference S16	0=off,1=on
56	Reference *Bestpos* Altitude	0=off,1=on
57	Reference Horizontal Speed	0=off,1=on
58	Reference Heading	0=off,1=on
59	undefined	0=off,1=on
60	undefined	0=off,1=on
61	undefined	0=off,1=on
62	undefined	0=off,1=on
63	undefined	0=off,1=on

3.3.16 Format-16 System Diagnostic Status

Table 41 defines the format and content of the message that provides collected System Diagnostic Status Information. Format 16 is sent from the Detection CPS to the Display Control Processor in response to a Format 4 command to provide the information.

Table 49 - Format-16 System Diagnostic Status Information

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00010000B
1	Reserved	24	TBD
4	Message Length	32	204
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Search Sensor Format 1 Count	32	1
20	Reference Sensor Format 1 Count	32	1
24	Count of Format 2 Messages	32	1
28	Count of Format 3 Messages	32	1

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
32	Count of Format 4 Messages	32	1
36	Count of Format 5 Messages	32	1
40	Count of Format 6 Messages	32	1
44	Count of Format 7 Messages	32	1
48	Count of Format 8 Messages	32	1
52	Count of Format 9 Messages	32	1
56	Count of Format 10 Messages	32	1
60	Count of Format 12 Messages	32	1
64	Count of Format 13 Messages	32	1
68	Count of Format 14 Messages	32	1
72	Count of Format 15 Messages	32	1
76	Search Sensor GPS Time Status	32	1
80	Reference Sensor GPS Time Status	32	1
84	Number Reset Attempts in this Reset Cycle.	32	1
88	Aligner Case 0 count	32	1
92	Aligner Case 1 count	32	1
96	Aligner Case 2 count	32	1
100	Aligner Case 3 count	32	
104	Aligner Buffer Low Threshold	32	
108	Aligner Buffer High Threshold	32	
112	Reset Attempt Limit	32	
116	Rest Millisec Slack	32	
120	Reserved for future use	32	
134	Reserved for future use	32	
138	Reserved for future use	32	
142	Reserved for future use	32	
146	Reserved for future use	32	
150	Reserved for future use	32	
154	Reserved for future use	32	
158	Reserved for future use	32	
162	Reserved for future use	32	
166	Reserved for future use	32	
*	*	*	*
200	Reserved for future use	32	*

3.3.17 Format 17 - Noise Reduction/Detection Initialization Status

Table 50 defines the format and content of the message which contains the notification to CPS Control that the NRD function has completed its initialization. Initialization completion status of 1 indicates successful initialization. A completion status of 0 indicates unsuccessful completion. Unsuccessful initialization will result in a System Fail Bit Status Code being sent to the Display Control Processor from the CPS in a Format 4 message.

Table 50 - Format-17 Noise Reduction/Detection Initialization Status

Relative Base Address (bytes)	Item	Size (bits)	LSB/Definition/Code
0	ID	8	00010001B
1	Reserved	24	TBD
4	Message Length	32	20
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	NRD Processor Initialization Status	32	1 = Initialized, 0 = Not Initialized

3.3.18 Format 18 – Command Track Generation

Table 51 defines the format and content of the Command Track Generation message sent from the Display Control Processor to the Detection Capable Computer Power Supply directing the generation of a track from two Operator selected detections for prediction of the path of a possible target and to provide the pertinent information from the two Format 8 Detection Data messages reporting the selected detections.

Table 51 – Format 18 Command Track Generation

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00010010B
1	Reserved	24	TBD
4	Message Length	32	168
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Detection 1 Message Count	32	Message Count value from the earliest Format 8 Detection selected by the Operator for use in Track Generation
20	Detection 2 Message Count	32	Message Count value from the latest Format 8 Detection selected by the Operator for use in Track Generation
24	GPS Time for detection data[22]	64	Seconds since midnight start of mission day GMT (DPFP)

[22] Related to Detection 1 identified by Detection 1 Message Count.

32	GPS Latitude for Detection Data[22]	64	Degrees (DPFP)
40	GPS Longitude for Detection Data[22]	64	Degrees (DPFP)
48	GPS Height above mean sea level for Detection Data[22]	64	Meters (DPFP)
56	Joint Detection Level [22]	64	Range (-1,1x10^6) (DPFP)
64	MAD Detection Level [22]	64	Range (-1,1x10^6) (DPFP)
72	ELF Detection Level [22]	64	Range (-1,1x10^6) (DPFP)
80	Slant Range[22]	64	Ft. (DPFP)
88	ELF Frequency Estimate[22]	64	Hertz (DPFP)
96	GPS Time for detection data[23]	64	Seconds since midnight start of mission day GMT (DPFP)
104	GPS Latitude for Detection Data[23]	64	Degrees (DPFP)
112	GPS Longitude for Detection Data[23]	64	Degrees (DPFP)
120	GPS Height above mean sea level for Detection Data[23]	64	Meters (DPFP)
128	Joint Detection Level [23]	64	Range (-1,1x10^6) (DPFP)
136	MAD Detection Level [23]	64	Range (-1,1x10^6) (DPFP)
144	ELF Detection Level [23]	64	Range (-1,1x10^6) (DPFP)
152	Slant Range[23]	64	Ft. (DPFP)
160	ELF Frequency Estimate[23]	64	Hertz (DPFP)

[23] Related to Detection 2 identified by Detection 2 Message Count

3.3.19 Format 19 Tracker Input Data

Table 52 defines the format and content of the Tracker Input Data message sent from the System Control Processor of the Detection Capable Computer Power Supply to the Track Generator for generation of a track from two Operator selected detections identified as CPA1 and CPA2 for prediction of the path of a possible target.

Table 52 - Format 19 Tracker Input Data

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
0	ID	8	00010011B
1	Reserved	24	TBD
4	Message Length	32	Variable dependent on WW (window width): 72 + ((WW*12)) *8+ ((WW*2))*4
8	Source MSN	16	See Manufacturer Serial Number Decode
10	Destination MSN	16	See Manufacturer Serial Number Decode
12	Message Count	32	1
16	Reserved	32	TBD
20	Window Width (WW)	32	LSB=1 See Note 24 , nominal value=301
24	Reference Position Latitude	64	Format 8 Latitude from selected detection CPA2 in Degrees (DPFP)
32	Reference Position Longitude	64	Format 8 Longitude from selected detection CPA2 in Degrees (DPFP)
40	Time of CPA1	64	Seconds since midnight start of mission day GMT (DPFP), From Format 8
48	Time of CPA2	64	Seconds since midnight start of mission day GMT (DPFP), From Format 8
56	Slant Range CPA1	64	Feet, From Format 8 (DPFP)
64	Slant Range CPA2	64	Feet, From Format 8 (DPFP)
72	AC Latitude Position (CPA1) window element 1	64	Format 1 GPS Data in Degrees (DPFP)
	. .		
72 + (WW-1)*8	AC Latitude Position (CPA1) window element WW	64	Format 1 GPS Data in Degrees (DPFP)

[24] The window width is required to be an odd number of 10 Hz data points (430 Hz points decimated to 10 Hz). This value is maintained in the CPS.

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
72 + (WW)*8	AC Latitude Position (CPA2) window element 1	64	Format 1 GPS Data in Degrees (DPFP)
	. .		
72 + ((WW*2) -1)*8	AC Latitude Position (CPA2) window element WW	64	Format 1 GPS Data in Degrees (DPFP)
72 + (WW*2)*8	AC Longitude Position (CPA1) window element 1	64	Format 1 GPS Data in Degrees (DPFP)
	. .		
72 + ((WW*3) -1)*8	AC Longitude Position (CPA1) window element WW	64	Format 1 GPS Data in Degrees (DPFP)
72 + (WW*3)*8	AC Longitude Position (CPA2) window element 1	64	Format 1 GPS Data in Degrees (DPFP)
	. .		
72 + ((WW*4) -1)*8	AC Longitude Position (CPA2) window element WW	64	Format 1 GPS Data in Degrees (DPFP)
72 + (WW*4)*8	AC Altitude Position (CPA1) window element 1	64	Format 1 GPS Data in Meters (DPFP)
	. .		
72 + ((WW*5) -1)*8	AC Altitude Position (CPA1) window element WW	64	Format 1 GPS Data in Meters (DPFP)
72 + (WW*5)*8	AC Altitude Position (CPA2) window element 1	64	Format 1 GPS Data in Meters (DPFP)
	. .		
72 + ((WW*6) -1)*8	AC Altitude Position (CPA2) window element WW	64	Format 1 GPS Data in Meters (DPFP)
72 + (WW*6)*8	AC Velocity (CPA1) window element 1	64	Meters/Second from Format 1 GPS Data (DPFP)
	. .		
72 + ((WW*7) -1)*8	AC Velocity (CPA1) window element WW	64	Meters/Second from Format 1 GPS Data (DPFP)

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
72 + (WW*7)*8	AC Velocity (CPA2) window element 1	64	Meters/Second from Format 1 GPS Data (DPFP)
	. .		
72 + ((WW*8) -1)*8	AC Velocity (CPA2) window element WW	64	Meters/Second from Format 1 GPS Data (DPFP)
72 + (WW*8)*8	AC Heading (CPA1) window element 1	64	Format 1 GPS Data Degrees (DPFP)
	. .		
72 + ((WW*9) -1)*8	AC Heading (CPA1) window element WW	64	Format 1 GPS Data in Degrees (DPFP)
72 + (WW*9)*8	AC Heading (CPA2) window element 1	64	Format 1 GPS Data in Degrees (DPFP)
	. .		
72 + ((WW*10) -1)*8	AC Heading (CPA2) window element WW	64	Format 1 GPS Data in Degrees (DPFP)
72 + (WW*10)*8	Noise Reduced Time Domain Values (CPA1) window element 1	64	Format 9 nT (DPFP)
	. .		
72 + ((WW*11) -1)*8	Noise Reduced Time Domain Values (CPA1) window element WW	64	Format 9 nT (DPFP)
72 + (WW*11)*8	Noise Reduced Time Domain Values (CPA2) window element 1	64	Format 9 nT (DPFP)
	. .		
72 + ((WW*12) -1)*8	Noise Reduced Time Domain Values (CPA2) window element WW	64	Format 9 nT (DPFP)
72 + (WW*12)*8	GPS Time CPA1 window data element 1	32	Milliseconds since Beginning of week from Format 1 GPS Data (Integer, LSB=1)
	. .		

Relative Base Address (bytes)	Item	Size (bits)	Definition Units/LSB Value/Other
72 + ((WW*12) *8+ ((WW*1)-1)*4	GPS Time CPA1 window data element WW	32	Milliseconds since Beginning of week from Format 1 GPS Data (Integer, LSB=1)
72 + ((WW*12)) *8+ ((WW*1))*4	GPS Time CPA2 window data element 1	32	Milliseconds since Beginning of week from Format 1 GPS Data (Integer, LSB=1)
	. .		
72 + ((WW*12)) *8+ ((WW*2)-1)*4	GPS Time CPA2 window data element WW	32	Milliseconds from Beginning of week from Format 1 GPS Data (Integer, LSB=1)

4. REQUIREMENTS TRACEABILITY

TBD

5. NOTES

5.1 Abbreviations and Acronyms.

3MDS	Multi-Mode Magnetic Detection System
AGC	Automatic Gain Control
ANC	Adaptive Noise Cancellation
AST	Applied Signal Technology, Inc.
B	Binary
BIT	Built-In Test
CFAR	Constant False Alarm Rate
CPA	Closest Point of Approach
CPS	Computer/Power Supply
D/A	Digital to Analog
DCP	Display/Control Processor
DPFP	Double Precision Floating Point
ELF	Extremely Low Frequency
FAR	False Alarm Rate
FFT	Fast Fourier Transform
GMT	Greenwich Mean Time
GPS	Global Positioning System
H	Hexadecimal
IDD	Interface Design Document
LSB	Least Significant Bit
MAD	Magnetic Anomaly Detection
mG	milli-Gs (Gravity)
mV	milli-Volts
nT	nano-Tesla
nT /ft^3	Magnetic Moment Unit of Measurement
P2K	Polatomic P2000 Magnetometer
PPS	Pulse Per Second
pT	pico-Tesla
PWB	Printed Wiring Board
Q	Indicator for dividing point between fractional and integer binary portions of a fixed point number in a memory or register location (also known as Q point arithmetic.

RF	Radio Frequency
RLLC	Resonance Laser Loop Control
TBD	To Be Determined
TCS	Tactical Control System
TEC	Thermal Electric Cooler
UAV	Unmanned Aerial Vehicle

5.2 Other

TLD

T - Transverse (aligned with the wings – positive right)

L - Longitudinal (aligned with direction of plane – positive forward)

D - Down (positive down – sometimes called Vertical with positive up)